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The Hawaiian Monk Seal in the Northwestern Hawaiian Islands, 2003

Compiled and Edited by

Thea C. Johanos
and
Jason D. Baker

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Pacific Islands Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
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For further information direct inquiries to

Chief, Scientific Information Services
Pacific Islands Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
2570 Dole Street
Honolulu, Hawaii 96822-2396

Phone: 808-983-5386
Fax: 808-983-2902

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Protected Species Division
Pacific Islands Fisheries Science Center
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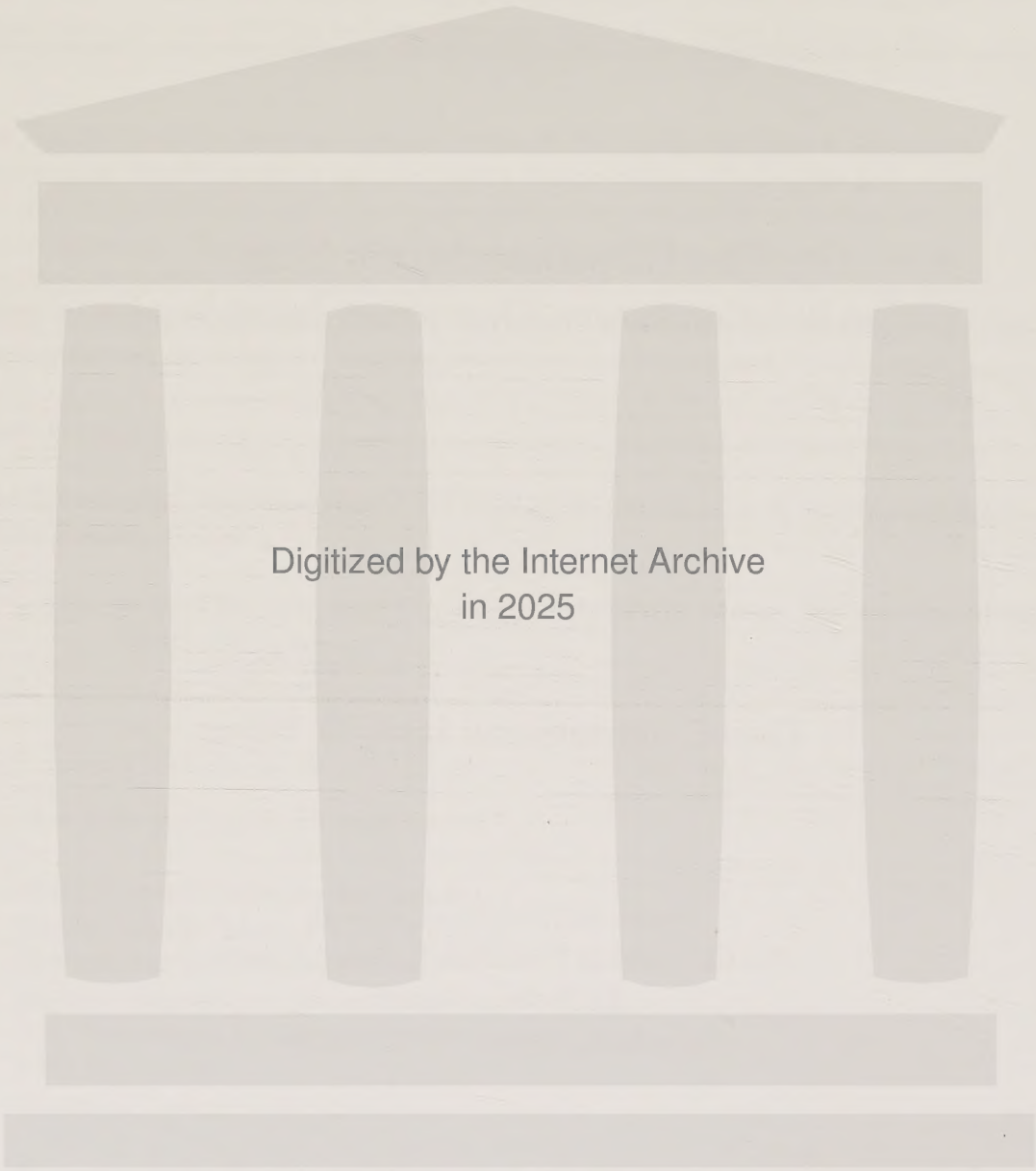

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EXECUTIVE SUMMARY

During 2003, field studies of the endangered Hawaiian monk seal (*Monachus schauinslandi*) were conducted at all of its main reproductive sites in the Northwestern Hawaiian Islands. These studies provide information necessary to identify and mitigate factors impeding the species recovery by evaluating (1) the status and trends of monk seal subpopulations, (2) natural history traits such as survival, reproduction, growth, behavior, and feeding habits, and (3) the success of various activities designed to facilitate population growth.

Results of these studies are best described on a site-by-site basis, and the information presented in this document is organized accordingly. Site-specific data pooled for all sites, however, provide useful indices of the status and trends of the species as a whole, including the total number of pups at all main reproductive sites, the total of the site-specific mean beach counts, and the size composition of the seals observed during the counts (Fig. 1).

Since 1983, the number of pups born at the main reproductive sites has been highly variable. In 2003, 176 pups were counted at these sites, 52 of which were born at French Frigate Shoals (FFS). Although a record number of pups were born at Midway Atoll, pupping at FFS was at its lowest level since monitoring began in the early 1980s. Mean beach counts, excluding pups, from the main reproductive sites totaled 331.1 seals. Counts remained essentially unchanged from 1993 to 2000, but declined in 2001–2003 (Fig. 1b).

From the mid-1980s to the mid-1990s, adults and pups made up a growing portion of the animals counted while juveniles and subadults declined (Fig. 1c), and in 2003, the composition of the counts again was dominated by adults and pups. This composition bodes poorly for reproduction in the near future because older adult females are not being replaced by sufficient numbers of maturing young females. High mortality of immature seals appears to have led to the shift in composition, particularly at FFS.

In 2003, the following activities were conducted by the Marine Mammal Research Program (Pacific Islands Fisheries Science Center, National Marine Fisheries Service) and cooperating scientists to enhance recovery of the species: (1) disentangling 11 seals and removal of debris capable of entangling seals; (2) guiding a seal stranded behind a deteriorating sea wall at FFS to the water's edge; (3) translocating 23 weaned pups between islets within FFS to decrease their risk of shark predation; (4) removing two Galapagos sharks after they exhibited predatory behavior toward monk seal pups at FFS; (5) cutting the umbilical cords to remove placentas from two newborn pups at risk of drowning or attracting sharks at FFS; (6) performing six human-assisted mother-pup exchanges (resulting in reuniting 4 pups with their mothers) at FFS, Laysan, and Lisianski Islands, and reuniting two separated mom-pup pairs at Laysan Island; (7) interrupting five

incidents of aggressive males mounting weaned pups at FFS, Laysan, Lisianski, and Kure Atoll; (8) monitoring beaches on Midway Atoll for disturbance and mitigating human impacts through education; and (9) rehabilitating a prematurely weaned pup at Midway Atoll.

This document describes these and other field studies conducted during 2003, and provides complete, standardized, and timely summaries of the research activities and findings at each study site. The availability of such information is essential for ongoing efforts to stop the decline of this species and enhance its recovery.

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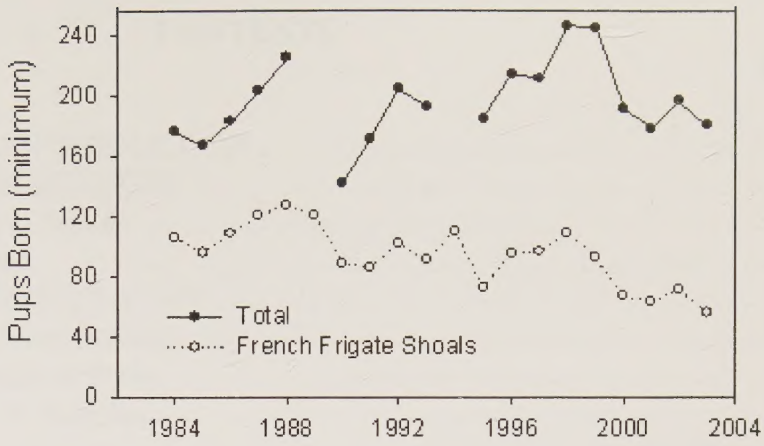

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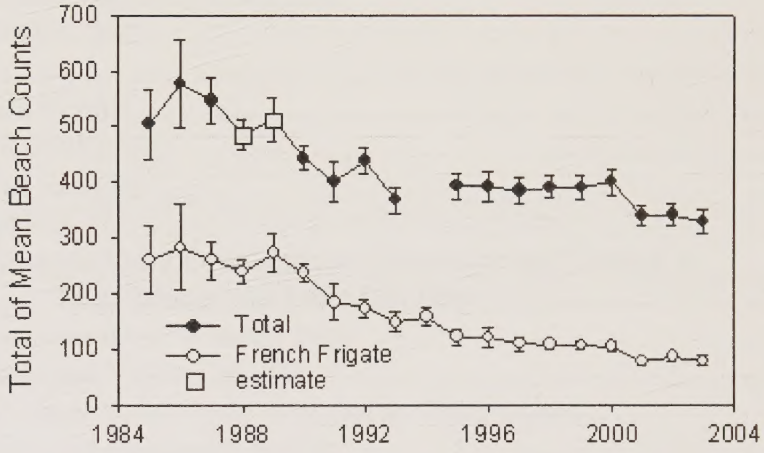

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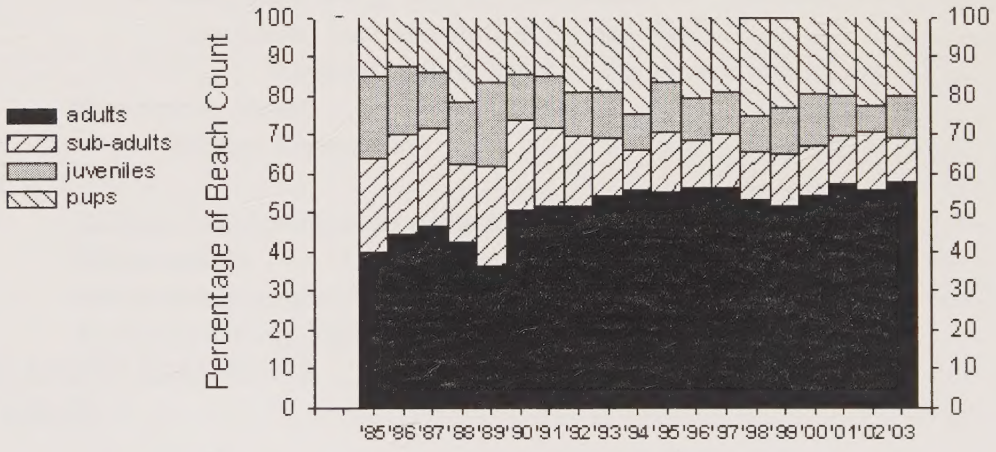

Figure 1.-- Demographic trends of the Hawaiian monk seal, based on the main reproductive sites. (A) Number of pups born (minimum). (B) Total of mean beach counts, excluding pups, with 1 standard deviation. (C) Percentage of counts comprised of adults, subadults, juveniles, and pups.

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CHAPTER 1. GENERAL INTRODUCTION

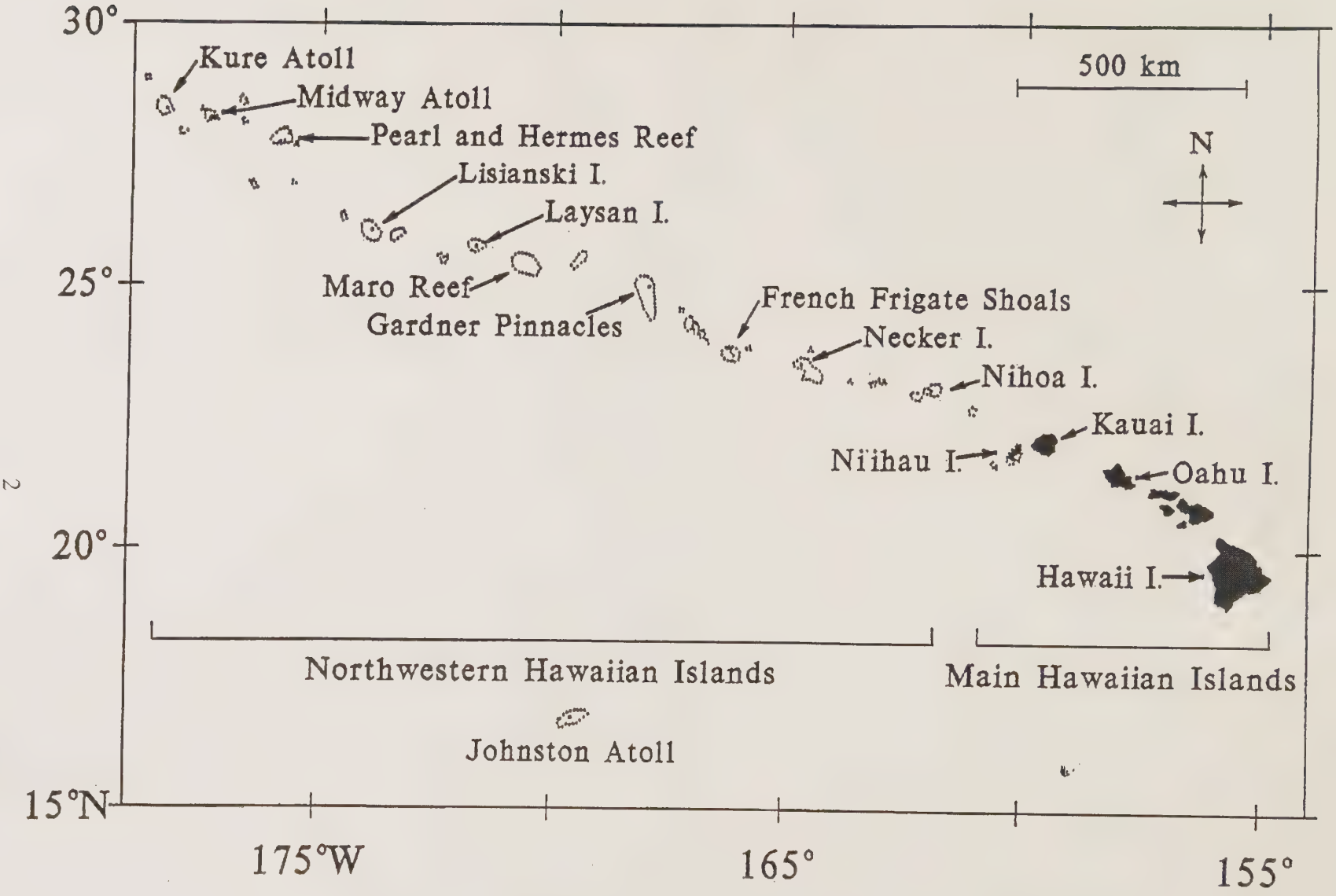

Fig. 1.1 The Hawaiian Archipelago.

The endangered Hawaiian monk seal's (*Monachus schauinslandi*) current core range is in the Northwestern Hawaiian Islands (NWHI, Fig. 1.1). The National Marine Fisheries Service (NMFS) is the lead agency responsible for the recovery of the Hawaiian monk seal. Each year the NMFS Pacific Islands Fisheries Science Center, Marine Mammal Research Program conducts studies at the main breeding sites to provide information necessary to evaluate (1) the status and trends of the monk seal subpopulations; (2) natural history traits such as survival, reproduction, growth, behavior, and feeding habits; and (3) the success of various activities designed to facilitate population growth.

The Marine Mammal Research Program began research on Hawaiian monk seals at most major reproductive sites in the NWHI during 1980 (Lisianski Island), 1981 (Laysan Island and Kure Atoll), 1982 (French Frigate Shoals (FFS) and Pearl and Hermes Reef), and 1983 (Midway Atoll). Nearly every year thereafter, field camps were established for periods of several days to 9 months to monitor and enhance the recovery of this species. Limited population monitoring has also been conducted at Nihoa and Necker Islands, where subpopulations appear to be limited to a small number of animals by availability of haulout area. Reports summarizing past NMFS research are listed in Appendix A.

In 2003, Hawaiian monk seal research activities included (1) conducting beach counts (censuses); (2) tagging weaned pups and other seals for permanent identification and retagging animals to maintain identification; (3) identifying other seals by previously applied tags and by natural or applied markings; (4) monitoring reproduction, survival, injuries, entanglements, interatoll movements, disappearances, and deaths; (5) performing necropsies; (6) collecting scat and spew samples for food habits analysis; (7) collecting skin punches and shed molt samples for a DNA tissue bank; (8) collecting samples of placentas found with or from aborted fetuses or with deceased perinatal pups for histological and bacteriological examination; (9) disentangling seals; and (10) removing debris capable of entangling seals from beaches. Location-specific objectives and summaries of data collected during the 2003 field season are described in the following chapters. Much of the information presented in this memorandum is incorporated into larger data sets for additional analysis and publication elsewhere. Research was conducted under the authority of the following permits: Special Use Permits 12520-03006, 02521-03011, and 02521-03021, and Marine Mammal Permits 848-1335 and 848-1695.

MATERIALS AND METHODS

Censuses and Patrols

The primary means of data collection were censuses and patrols. Censuses consisted of timed, standardized beach counts during which an entire island or atoll was surveyed for seals. Although data were collected on all seals, those that were in the water, captive, or dead were excluded from the beach count totals. Identified individuals were counted only once if they were resighted during the survey. The resulting counts did not reflect total population size but provided an index of population size for comparison among years and locations. Data collected on each seal observed during censuses included size class (ranging from pup, juvenile, subadult, and adult size as described in Stone, 1984 and Appendix B); sex; location on the island; beach position (indicating whether the seal was in the water or on land); body condition (a subjective estimate; e.g., fat, medium, or thin); identification information (permanent or temporary identification numbers and tag numbers); molting status (an estimate of the percentage completed); and disturbance index (the extent that the observer disturbed the seal). Further data were collected if any of the following events occurred: (1) factors affecting survival (e.g., entanglements, mobbings, or shark injuries), (2) animal handling, (3) photography, and (4) documentation of tag condition (e.g., good or broken). In addition, behavioral data (seal associations and interactions) were collected on Laysan and Lisianski Islands. A sample census form and guidelines for its completion are included in Appendix B. Censuses were conducted once at Nihoa Island and every 4 to 10 days at all other locations, starting at 1300 Hawaii Standard Time when possible, using census methods and criteria outlined in Johanos et al. (1987). Atoll-wide counts for locations with more than a single island (French Frigate Shoals, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll) were completed within a 2-day period. The perimeter of each study area was divided into sectors to facilitate the analysis of data and detection of demographic trends in different geographic areas. Census methods specific to each location are detailed in the following chapters.

Patrols consisted of untimed surveys of an entire island perimeter on foot. Information collected during patrols was similar to that collected during censuses. Because patrols were not timed, observers concentrated on documenting adult and subadult behavior, identifying and marking individuals, and collecting scat and spew samples. Island-specific standardized patrols were conducted at some locations and are described in the following chapters.

During all observation periods (i.e., censuses, patrols, and incidental sightings), observers attempted to minimize seal disturbance by walking above the beach crest and using vegetation as a visual barrier. On census days, activities that threatened to disturb the animals and bias the count were not conducted until after the count was completed. Additionally, the following were recorded whenever observed: (1) births, pup exchanges,

and weanings; (2) mating activities, adult male aggression, and post-mobbing aggregations (defined below); (3) entanglements in marine debris; (4) injuries; and (5) deaths.

Reproduction

Parturient females were identified when possible, and birth and weaning information was recorded. Because parturient females will nurse pups other than their own (Boness, 1990; Boness et al., 1998), efforts were made to identify pups and document changes in nursing relationships from birth to weaning. A pup exchange occurred when the pups of two lactating females were switched or one nursing female suckled multiple pups. Typically, such exchanges occur during an aggressive interaction between the two females. On other occasions, a mother and pup become separated, and one or both seals then actively seek and obtain another nursing relationship (Boness, 1990).

The average nursing period was calculated for some or all pups at each location. The average lactation period of parturient females was also calculated for seals at FFS because higher population density and frequent pup exchanges (Boness, 1990; Boness et al., 1998) made it difficult to track individual pups and determine their nursing period. Nursing or lactation periods were defined as the number of days from birth until the end of the last nursing relationship. Temporary breaks (e.g., if a mother and pup became separated and one or both seals subsequently obtained another nursing relationship) were not subtracted from the total. When the exact birth or weaning date was not known but occurred within a range of 4 days or less, then the midpoint of that range was used as the start or end date for calculation of average nursing or lactation period. Nursing or lactation data were not used if the birth or weaning range exceeded 4 days or if the pup died or disappeared before weaning. Prior to 2002, nursing or lactation periods of less than 20 days were also excluded from calculations.

Factors Affecting Survival

The origins of a wide range of injuries were distinguished based on characteristic wound patterns described in Hiruki et al. (1993). Injuries were documented if they were related to attacks by large sharks, mounting attempts by male Hawaiian monk seals, or entanglement in marine debris or if they were considered severe enough to possibly affect survival. Injuries were considered severe, and were summarized if they consisted of (1) the total combined area of all abscesses or abscess-like raised areas was $\geq$ 8 cm diameter circle area (approximately 50 cm^2); (2) an amputation of a minimum of half a flipper (either foreflipper or hindflipper); (3) the total combined exposed area of all punctures or gaping wounds was $\geq$ 8 cm diameter circle area; or (4) densely spaced (overlapping)

scratches, abrasions, or lacerations covering an area equivalent to half the dorsum, or evidence of extensive underlying tissue damage (e.g., an uneven or darkened surface of the injured area, leaching fluids), or impaired seal movement. Major healed injuries that had been incurred since the previous season were documented but not included in summaries.

A seal was listed as dead if its death or carcass was observed. Deaths summarized here include carcasses found at the beginning of the field season if the seal had clearly died during the calendar year. A seal was listed as probably dead if it sustained severe injuries or was emaciated (with skeletal structure clearly evident) and subsequently disappeared. In addition, one of the following conditions must have been satisfied to place a seal in the "probably dead" category: (1) the seal was lethargic, had difficulty moving, or floated listlessly in the water, and disappeared more than a week before the end of data collection for the field season, or (2) the seal was in deteriorating condition (loss of weight, enlargement of abscesses, sloughing of skin) and disappeared a minimum of 10 surveys or 1 month before the end of data collection for the field season (whichever was longer). Nursing pups were listed as probably dead if they disappeared within 3 weeks of birth. Losses of apparently healthy older nursing pups (over 3 weeks of age) and newly weaned pups (within 2 weeks post-weaning) were listed as disappeared, suspected dead, if the pups were last seen a minimum of 10 surveys or 1 month before the end of data collection.

Multiple male aggression (or "mobbing") and other mating-related male aggression were observed and recorded. By definition, multiple male aggression occurred when more than one male attempted to mate with a single seal, usually an adult female or immature seal of either sex, causing injury or death of that seal (e.g., Alcorn, 1984). Single male aggression was defined as any incident where an adult or subadult male repeatedly bit the dorsum, attempted to mount, and tried to prevent the escape of another seal. These incidents were summarized in this report if they simultaneously involved more than one male aggressor, resulted in a minimum of one puncture or gaping wound (missing skin or extending into the blubber layer) or $\geq$ 15 scratches to the dorsum or flanks or if intervention was required to prevent drowning. Post-aggression aggregations were also summarized: these were groups of males congregated on the beach, attending a seal with new mounting injuries as described above.

Individual Identification

During censuses and patrols, individual seals were identified with tags, applied bleach marks, scars, or natural markings. After weaning, pups were tagged on each hind

flipper with a colored plastic Temple Tag,®[1] uniquely coded to indicate island or atoll subpopulation, year of birth, and individual identification number (Gilmartin et al., 1986). In addition, a passive integrated transponder (PIT) tag was implanted subcutaneously in the posterior dorsum of most weaned pups (see Lombard et al., 1994, for detailed tagging procedures).

Colored plastic Temple Tags have been applied to nearly all weaned pups since 1981 at Kure Atoll; since 1982 at Lisianski Island; since 1983 at Laysan Island and Pearl and Hermes Reef; since 1984 at French Frigate Shoals; and since 1995 at Midway Atoll. Pups at Midway Atoll, Necker and Nihoa Islands, and the main Hawaiian Islands have been tagged opportunistically since 1983. Since 1991, PIT tags have also been implanted subcutaneously in the ankle (1991) or the posterior dorsum (all subsequent years) of most weaned pups.

In 2003, untagged immature and adult seals were opportunistically tagged with Temple Tags uniquely coded to indicate that their ages and birth locations were unknown. These seals also received PIT tags. Seals with lost or broken tags were retagged to maintain their identities.

Seals were bleach-marked for individual identification (Stone, 1984), using the solution described in Johanos et al. (1987), and applied bleach marks were photographed and sketched onto scar cards. Molting seals were re-marked with bleach to maintain their identities until the next molt. Some nursing pups were also bleach-marked prior to the post-natal molt to facilitate identification during the nursing period.

Digital photographs of scars and natural markings were added to individual identification folders throughout the field season to maintain a current description of the identifying marks of each seal.

Minimum subpopulation abundance and size-sex composition are presented. These statistics included all individuals observed alive at the location during the interval from March through August and all known parturient females and pups born anytime during the year.

The movement of seals among island or atoll subpopulations within and between years complicates the estimation of minimum subpopulation size and composition. This is particularly true at Midway Atoll, where a number of the observed seals were tagged at other locations (primarily Kure Atoll and Pearl and Hermes Reef). Therefore, standardized rules for assigning each seal identified to just one subpopulation are applied as follows. If a seal was observed at more than one location during March-August, it was

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[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

included exclusively in the subpopulation where it was sighted nearest to May 15, unless it pupped or molted at another location. A parturient female was always exclusively included in the subpopulation where she pupped, and a non-parturient seal was exclusively included in the subpopulation where it molted. Pups were always exclusively included in the subpopulation where they were born.

Measurements of Seals

Pups were measured to provide information on condition. Measurements were taken as soon after weaning as possible, and measurements taken within 2 weeks after weaning were included in the summaries. Measurements included straight dorsal length (Winchell, 1990) and axillary girth (American Society of Mammalogists, 1967). Some older animals captured for retagging, foraging ecology, health, or disease studies were also measured.

Collection of Samples

Samples were collected for a DNA tissue bank, pathology analysis, investigation of food habits, and documentation of marine debris. Tissue punches for DNA were collected during tagging efforts for all newly tagged or retagged seals and during necropsies on seals that had recently died. Samples of placentas found with or from aborted fetuses or deceased perinatal pups were also collected.

For each dead seal recovered, an external examination was made, photographs were taken, and external measurements and observations were recorded. For a recent death, an internal examination was made, and samples of tissue, organs, parasites, and stomach contents were collected. Detailed descriptions of necropsy procedures and sample collection methods are in Winchell (1990).

Scat and spew samples were collected opportunistically for analysis of food habits (Goodman-Lowe, 1998). These samples were collected from seals of known size and sex class when possible.

Nets, lines, ropes, and other debris capable of entangling seals and turtles were removed from beaches. From 1982 to 1998, potentially entangling marine debris was incinerated on site at all locations, and debris incineration continued at Kure Atoll through 2001. More recently, marine debris was removed by ship.

CHAPTER 2. THE HAWAIIAN MONK SEAL ON FRENCH FRIGATE SHOALS, 2003

Suzanne M. Canja, Brenda L. Becker, Aaron Dietrich, Shawn C. Farry, Jennifer L. Palmer, Dan F. Luers, and Misty E. Niemeyer

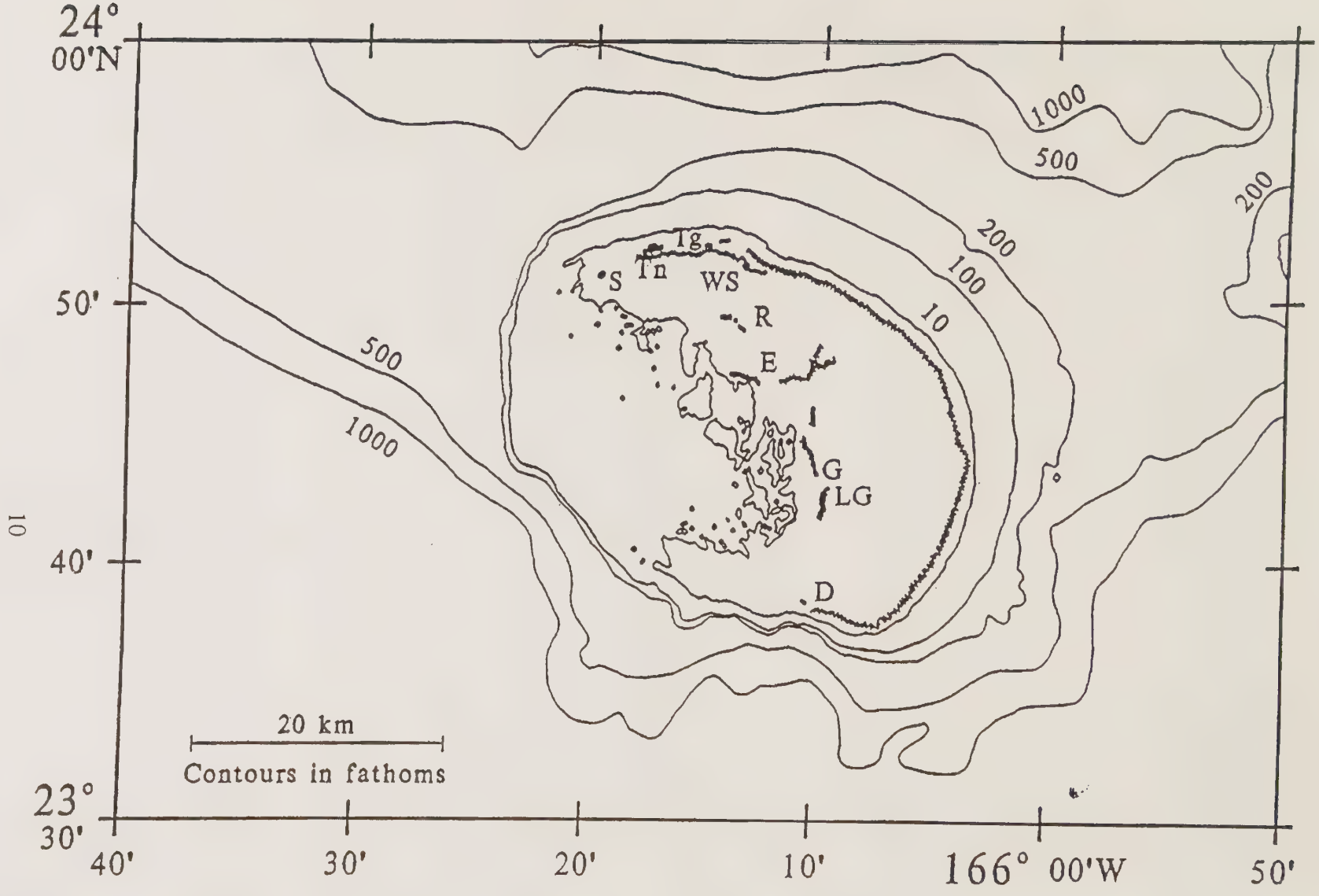

Fig. 2.1. French Frigate Shoals in the Northwestern Hawaiian Islands. Islands are: Disappearing (D), East (E), Gin (G), Little Gin (LG), Round (R), Shark (S), Tern (Tn), Trig (Tr), and Whaleskate (WS).

The largest subpopulation of Hawaiian monk seals is located at French Frigate Shoals (FFS, lat. 23°45' N, long. 166°10' W), ca. 830 km northwest of Oahu in the Northwestern Hawaiian Islands. This atoll is part of the Hawaiian Islands National Wildlife Refuge (Fig. 1.1) and consists of nine permanent islets (Disappearing, East, Gin, Little Gin, La Perouse Pinnacles, Round, Shark, Tern, and Trig), three semipermanent islets (Bare, Mullet, and Whaleskate), and several transient sand spits (Fig. 2.1).

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at FFS in 1982. In 2003, research was conducted by NMFS from April 22 to September 9. Incidental observations were recorded by U.S. Fish and Wildlife Service (USFWS) personnel during the rest of the year. The perimeters of the five larger islets (East, Gin, Little Gin, Tern, and Trig) were divided into sectors using artificial or natural landmarks. Research activities specific to this subpopulation in 2003 included (1) monitoring and removal of Galapagos sharks preying on monk seal pups at Trig and Round Islands; (2) translocating newly weaned pups to reduce their risk of shark attack; (3) retagging or newly tagging seals; (4) observing adult male aggression at East Island; (5) tagging Galapagos sharks to determine movement patterns within the atoll; (6) collecting organisms for a Hawaiian monk seal prey fatty acid analysis; (7) assessing seal foraging using archival movement recorders imbedded in simulated "rocks"; and (8) conducting videographic surveys of benthic habitat.

Censuses and Patrols

Atoll-wide censuses (n = 10) were conducted every 6 d, on average, from May 27 to July 27. Each atoll census required 2 d to complete. Disappearing, Round, Bare, and Mullet islets were surveyed either on foot or by boat; while the remaining islets (East, Gin, Little Gin, Shark, Tern, Whaleskate, and Trig) were censused on foot by 1–4 people. Bare Island was rarely above water during the season and Mullet was completely submerged by August 13. Whaleskate Island was present the entire season and larger than Round Island.

Individual islet censuses and patrols were scheduled to ensure the entire atoll was monitored at least once each week during May 27–August 25. However, surveys at all islands, except Disappearing and Shark, commenced May 13. Surveys were more frequent at islets where most pups were born and nearby sites, and sites of high shark activity: Trig was monitored daily, Round approximately every 1–2 d; East, Gin, Little Gin, Mullet, Tern, and Whaleskate islets were monitored on average every 2–4 d; and

Bare, Disappearing, and Shark averaged every 6–8 d. Survey frequency at Round Island was greater than in previous years because Galapagos sharks were observed patrolling the nearshore waters and one nursing pup sustained a serious shark bite. Also, because of high levels of shark predation of pups at Trig Island in previous years, daily surveys began April 22 and increased to twice daily May 25–September 2. Seals were surveyed at the beginning and end of each day of shark observations at Trig. Surveys at Little Gin Island increased to every 1–2 d from July 24 to August 4 because of an unusual increase in large shark sightings there.

Individual Identification

A total of 291 individuals (239 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Bleach marks were applied to 70 seals, including 23 nursing pups. Thirty-seven weaned pups were tagged with Temple Tags; 34 of which also received a passive integrated transponder (PIT) tag. Two of these pups were tagged by USFWS personnel post-field season, and two weaned pups were not tagged because of their compromised conditions (one sustained a severe injury to both hindflippers and the other was likely blind). Additionally, four male seals were retagged (three adults, one subadult) and one adult male was newly tagged with Temple and PIT tags.

Collection of Samples

Twenty-nine scat and one spew samples were collected. Fifty skin punches were collected. Necropsies were performed on nine of 11 carcasses (includes four fetuses and a mummified carcass believed to have died prior to 2003). Shed molt samples from two seals, and ten fresh placentas were also collected. A total of 307 fish and invertebrates representing 48 species were collected for fatty acid analysis. Potentially entangling marine debris was collected and stored in a secure location on Tern Island pending removal. In addition, three items that had entangled seals were also collected.

Special Studies

Galapagos Shark Observations, Deterrence and Culling at Trig, Round, and Little Gin Islets

Trig Island--From April 22 through September 8, Trig Island was monitored daily to document the presence of Galapagos sharks and their predatory behavior towards monk seal pups. Observations were conducted on 125 days (excluding nine weather/logistical days) between 0600 and 2015 for a total of 929.5 hours

(avg. 7.4 hr/day). To observe during early morning and late afternoon hours, the Trig observation team spent 16 non-consecutive nights on the island. Two Galapagos sharks which exhibited predatory behavior towards monk seal pups were lethally removed. Samples were collected and morphometrics taken from both of these animals. Three pups disappeared and are suspected dead (two nursing and one near weaning), and minor shark injuries were inflicted to two other pups (one nursing and another near weaning). Detailed results of the shark studies conducted on Trig Island and at other locations within FFS will be presented elsewhere.

Round Island--On May 30, a large Galapagos shark was seen in the shallow waters next to Round Island where three nursing pairs were present. Daily observations were conducted from May 30 to June 4 (excluding June 3) to monitor shark activity. Observations ranged from 0.2 to 2.8 h and occurred between 1250 and 1625 for a total of 5.25 h. Sharks were seen May 30—one Galapagos shark; May 31—two sharks (species unknown); June 1—one Galapagos shark; June 2—no sharks; and June 4— four Galapagos sharks. On June 4, one nursing pup was discovered with a fresh, severe shark injury, resulting in loss of one entire hindflipper and half of the other. At the time of this sighting, four Galapagos sharks were seen simultaneously, actively patrolling the area and two direct aggressive approaches to a nursing pair in the water by 1–2 sharks were witnessed. The adult female successfully fended off the sharks and then immediately exited the water with her pup. To more closely monitor seal/shark interactions, Round Island surveys were increased to every 1–2 d from May 27 to August 13.

Boat-based observations were conducted from June 5 to June 13, between 0700 and 1745 for a total of 41.5 h (range 1.5-10 hrs/day) over 8 of the 9 days. Round Island shark observations were only conducted when Galapagos shark activity was seen or suspected, e.g., Galapagos sharks seen patrolling or a pup injury, death, or disappearance was attributed to shark predation. No sharks were removed here; however, two unsuccessful attempts were conducted on June 5. One nursing pup disappeared and probably died, and another pup was seriously compromised because of its limited mobility as a result of the complete loss of one and the partial loss of the other hindflipper from a shark attack.

Little Gin Island--Because of shark activity observed near Little Gin on July 22, incidental observations were conducted on 18 days between July 22 and September 2. These observations were conducted from a boat anchored off the southwest side of the island, just outside the reef break at the entrance of a bay. Observations ranged from 0.2 to 1.9 h and occurred between 1000 and 1650 for a total of 21.5 h. Large sharks (both Galapagos and tiger sharks) were seen on 9 days from July 22 to July 29 (no observations July 23) and August 7 and August 25 when one to four large sharks were seen during observations.

The majority of observed shark activity occurred along a shallow reef northwest of the bay opening, approximately 33 m from the island, where a strong odor of undetermined origin was detected during July 22–August 2. Tiger sharks were seen on 6 days during this period, with a maximum of three tiger sharks seen in 1 day. On one occasion, a tiger shark patrolled the shoreline, passing within a few feet of a nursing pair on the beach. One very large (4.0–4.3 m) tiger shark was uniquely identifiable and observed on 2 successive days. Galapagos sharks were seen on 4 days (July 22, 24, 26, and August 25) with a maximum of two sharks seen in a day. Galapagos shark sightings were brief and usually occurred near the previously mentioned reef area. The exception was on August 25, when a probable Galapagos shark cruised along the shoreline 30 minutes after a dead, shark bitten pup had been recovered by researchers from the wave wash. A Galapagos shark was also seen near the boat within an hour after the carcass was recovered.

Seals, primarily weaned pups, were observed in the water simultaneously with sharks on 4 days. No sharks were seen to approach seals. The only observed shark injury at Little Gin resulted in the death of a nursing pup (the carcass mentioned above). In addition, an apparently healthy 29–35-day-old pup disappeared near weaning between August 14–18 and is suspected dead. Two weaned pups that had been translocated to Little Gin from Trig Island also disappeared, both within a week after translocation; one was translocated on June 22 and was last seen June 29, the other was translocated on July 19 and was last seen July 21. Notable shark activity was first observed on July 22.

Translocation of Weaned Pups

To improve weaned pup survival, newly weaned pups were translocated from areas of high shark predation risk to islets with lower evidence of shark activity. The majority of these pups were moved on the day of weaning. Because of weather or logistical constraints, three pups (2 Trig, 1 Whaleskate) were translocated within 2 days of weaning. This included an unusual observation where both the mother and pup disappeared near the time of weaning from Trig and then 2 days later the pup reappeared alone and weaned. Two pups were temporarily held in a pen on Trig to prevent them from venturing into the water before they could be translocated.

Little Gin was the primary release site, because there were no nursing pairs present (until mid-July) with which the weaned pups might interact. By July 19, twelve newly weaned pups had been translocated to Little Gin and two had disappeared within a week of translocation. Because of the shark activity and the pup disappearances noted above, all newly weaned pups from Trig and Round Islands were taken to Tern Island after July 23.

All 23 newly weaned pups from Trig (18), Round (4) and Whaleskate (1) islets were translocated, with two nursing pups remaining on Trig at the end of the season.

Twelve were taken to Little Gin (from Trig-10, Round-1, Whaleskate-1), one pup to Gin (from Trig), and 10 pups to Tern (from Trig-7, Round-3). One Trig Island pup was translocated twice; initially from Tern to Trig Island when it was 13 days old. This nursing pup swam from Trig to Tern Island and was held in a cage overnight until it could be returned to its birth mother on Trig the next day. This pup was translocated again, this time from Trig back to Tern, after it weaned.

East Island Video Cameras

As part of the turtle nesting and basking behavior studies directed by George Balazs (NMFS PIFSC), two remote video cameras were mounted at 13.7 m and 19.8 m above ground, to the pole located near the center of East island. These solar powered, pan-tilt zoom cameras with digital photo and video capabilities were remotely controlled from the Tern Island field station 7 miles away. Thirty-nine preset locations were programmed to photograph the entire island perimeter daily at 2-h intervals from 0600 to 2000. Researchers were free to use the *Turtle Cam* to monitor other wildlife when the programmed photos were not being taken. This proved especially valuable in monitoring monk seals, noted below.

East Island Adult Male Aggression Observations

On July 16, two incidents of adult male monk seal aggression towards two weaned pups were observed on East Island within an hour. One incident was halted by researcher intervention. Following these events, observation effort was substantially increased at East Island to determine the persistence and extent of this behavior and the effects on the weaned pups. Daily incidental observations began July 19 through September 7, with three exceptions: July 22 and August 1 and August 21. The majority of these observations were conducted via the *Turtle Cam* from the Tern Island field station, allowing researchers to remotely scan the entire island and to video document pertinent events. In all, 48 days of observations were conducted, including both standard on-island surveys (13) and *Turtle Cam* video surveys (45). Both types of surveys were performed on 10 days. Observations were conducted between 0632 and 2011 and ranged from 4 min to 8.5 h for a total of 58.1 h (47.3 h using the remote video cameras).

The adult male (identifiable by tags and a large applied dorsal bleach mark) that had been observed harassing pups on July 16, was present on 11 of the 48 survey days. He was typically observed either sleeping on the beach or cruising in the water near shore. He was observed with weaned pups on four occasions (excluding the initial observation on July 16); two times sleeping near a pup (ranging 1–6 m away), once investigating a pup hauled out on the beach and then leaving, and once attempting to mount a pup in the water. This last incident, occurring on August 16, was aggressive and at times included

holding the pup underwater. Although not constant harassment, the interaction lasted 8 minutes and ended when the adult male left the area and hauled out alone to sleep for a few hours before leaving the islet for the evening. Only minor injuries were inflicted to the pups during the July 16 mounting attempts. One of the weaned pups mounted on July 16 had been sighted 4 days previously with two slightly raised areas on its dorsum (approximately 10–15 cm diameter). That injury was believed to be seal inflicted, but did not appear to change in size during the field season, nor did the pup appear compromised.

Tagging of Galapagos Sharks

From August 1 to August 15, a team was deployed to capture, measure, and tag Galapagos sharks to investigate their movements and site fidelity within FFS. This was the fourth and final year of a study initiated in 2000 and was conducted in collaboration with California State University Long Beach, Hawaii Institute of Marine Biology, and the NMFS Narragansett Laboratory. Fishing efforts were primarily focused near Trig and Round Islands where known Galapagos sightings have occurred, with some effort also near East, Shark, Tern, and Whaleskate Islets. No Galapagos sharks were captured. Five gray reef and two whitetip sharks were captured and two of the gray reef sharks were tagged with conventional ID tags. In addition, 10 previously installed acoustic monitoring stations were serviced and downloaded twice during the field season.

Foraging Ecology and Habitat Studies

In October 2003, NMFS PISFC Ecosystems and Oceanography Division personnel continued efforts to provide reference material for fatty acid analysis of monk seal prey items. Sand trawls were conducted on the deep terrace on the north side of the atoll and shallow reef fish and invertebrates were collected by divers within the atoll using pole spears. Mixed gas divers also recovered archival movement recorders imbedded in simulated "rocks," which had been redeployed the previous year on the 70-m north slope of the atoll to monitor year-round seal foraging activity. Videographic surveys were also conducted to map benthic habitat types.

Tern Island Seal Monitoring for Seawall Reconstruction Project

To monitor the potential effects on haulout patterns of monk seals prior to and during the Tern Island seawall reconstruction project scheduled to begin in 2004, USFWS personnel conducted weekly "rapid assessment" seal censuses from mid-September through the end of the year. These baseline data were given to NMFS for analysis of the effects of this construction project.

Noteworthy Events

Human Intervention

In January, USFWS personnel assisted a molting adult male who had strayed to the far northwest corner of Tern Island above the seawall. To help guide the seal back to the water, a ramp was made and the seal was coaxed safely over the seawall uninjured into the water. During the field season, researchers halted aggressive male mounting of a weaned pup on East Island (mentioned above), and cut the umbilical cords (and collected placentas) of two newborn Trig Island pups because the attached placentas restricted movement and placed the pups in danger of drowning or attracting sharks. In one case, the attached placenta was in the wavewash attracting a Galapagos and gray reef sharks (the Galapagos shark was lethally removed during this incident).

Four human-assisted pup exchanges (all on Trig Island) occurred when researchers intervened to improve the survival of a nursing pup. Researchers also attempted to foster two small weaned pups to adult females who had lost their pups 2–6 days earlier; although neither attempt was successful.

RESULTS

Subpopulation Minimum Abundance and Composition

The mean (± SD) of 10 atoll censuses was 102.3 seals (± 13.6) including pups, and 79.5 seals (± 8.6) excluding pups (Table 2.1). The total number of seals identified as part of the spring-summer subpopulation was 290 individuals, 238 excluding pups (Table 2.2). This number is a subset of the total identified in the calendar year, and is an unknown proportion of the total subpopulation as many of the older, untagged seals couldn't be uniquely identified. The numbers of tagged known-age seals born at FFS during the period from 1984 to 2002 and resighted at any location in 2003 are summarized in Table 2.3.

Reproduction

At least 52 pups were born at FFS in 2003: 39 pups successfully weaned (including 2 nursing at the end of the NMFS field season), 7 died or probably died prior to weaning; 3 pups older than 21 days suspiciously disappeared prior to weaning; and the weaning status is unknown for 3 pups (2 disappeared at/near weaning and 1 pup was still nursing at the end of the NMFS season) (Table 2.4a). The following were birth locations for these pups: 23 born at Trig, 9 at East, 6 Gin, 5 Round, 4 Tern, 2 Little Gin, 1 Shark, 1 Whaleskate, and 1 born at an unknown location (weaned prior to the field season). The

birth at Shark Island was the first documented since 1998, and the birth at Whaleskate Island was the first known since 1999. Since 1996, the presence of Whaleskate Island has been intermittent. Nursing periods and measurements of weaned pups are summarized in Table 2.4b. Seven births and six weanings were observed, all on Trig Island. Thirty-five pup exchanges were documented between 23 adult females; 19 of these events were observed and 4 of these involved human assistance to improve survival. A minimum of 21 pups were fostered by mothers other than their own (15 Trig, 4 Round, 1 Gin, 1 East). In addition to pups listed in Table 2.4a, four fetuses were found during February and March.

Interatoll Movement

Interatoll movement was documented for three seals that completed a total of five movements between FFS and Laysan Island (Tables 2.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by male Hawaiian monk seals, entanglement in marine debris, emaciation, and unknown factors led to 24 life-threatening conditions, which resulted in the confirmed deaths of 6 seals and the probable deaths of 5 seals (including 4 nursing pups less than 3 weeks old) (Table 2.6). In addition to the incidents presented in Table 2.6, seven pups disappeared and are suspected dead (two newly weaned, two near weaning, and three nursing pups older than 3 weeks old).

Of 52 pups born at FFS this year, 2 pups (both nursing) were seriously bitten by sharks: one died (at Little Gin) and the other (at Round Island) had most of its hindflippers amputated. Galapagos sharks were observed at the time both of these injuries were discovered. The pup with the amputated hindflippers was translocated to Tern upon its successful weaning, and remarkably made a round-trip transit from Tern to Trig Island 9 weeks post-weaning. This seal was seen through the end of December though its long-term survival was likely compromised by limited mobility. Three additional pups (two weaned male and one nursing female) received very minor shark injuries, not serious enough to include in Table 2.6. Two of these injuries occurred on Trig; one to a male pup near weaning and the other to a female nursing pup. Both pups were immediately translocated and the injuries healed. One weaned pup, born at Trig and translocated to Little Gin in June, was seen back at Trig Island mid-August with a healed minor shark bite to its left posterior.

Shark attack was the likely cause for the disappearances of 11 other pups; this includes the probable deaths of the four nursing pups, and the suspected deaths of the

seven other pups mentioned earlier. Three pup disappearances occurred each at Trig and Little Gin (including two translocated weaned pups at Little Gin) two at East, two at Gin, and one on Round Island. Shark attack was the suspected cause for all these disappearances, as the pups appeared healthy and normal. There were typically multiple sightings of Galapagos sharks patrolling Trig, Round, and Little Gin Islets near the time of the disappearances. In seven of nine cases involving nursing pups, the parturient female was present and actively searching for her missing pup, confirming that the pups had not been weaned. The two weaned female pups, both translocated from Trig to Little Gin, disappeared within 1 week post-weaning. It is highly unusual for apparently healthy weaned pups in good condition to not be seen consistently for at least the first month after weaning. Shark activity was observed the day after the second pup was last sighted.

Three seals were observed entangled in marine debris; a subadult male and a female weaned pup both on Tern, and a parturient female on Trig. USFWS personnel observed the entangled subadult seal on Tern Island in January (prior to the NMFS field camp) and were able to cut the net free from its neck. The parturient female was only briefly entangled when she investigated a net in the water and was able to free herself after violently thrashing around. Fortunately her pup was not involved in the incident. A weaned pup was discovered on Tern Island (at the US Coast Guard dump site) with a rubber gasket loosely fit around its neck; however, the pup had freed itself by the time observers returned intending to free it.

Also in addition to incidents presented in Table 2.6, four fetuses were found by USFWS staff during February and March, the desiccated carcass of an immature seal believed to have died prior to 2003 was found in May, and two seals were observed with healed shark injuries inflicted since the previous season (an adult female and yearling female, with severe and minor healed injuries, respectively). Also of note, a nursing pup had an unusual eye condition with possible vision impairment. Though this pup successfully weaned, it was not tagged to avoid any risk of injuring the seal's eyes. This seal was last observed October 21. Another unusual case involved a 2-year-old male who did not undergo an annual molt. The seal was unmolted in July 2002 when instrumented with a CRITTERCAM as a yearling. The instrument mount was still attached to his shoulder area in 2003 confirming he had not molted in 2002. At the beginning of the 2003 season this animal was thin, and though his body condition did improve, he did not molt during the field season.

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TABLES
for French Frigate Shoals

Table 2.1.--Summary statistics for atoll censuses (n = 10) of Hawaiian monk seals at French Frigate Shoals from May 27 to July 27, 2003.

Size/Sex	Mean number of individuals	Standard deviation
Adults	58.7	8.7
Male	18.9	4.4
Female	37.5	6.4
Unknown	2.3	1.3
Subadults	8.2	3.0
Male	4.3	2.1
Female	3.4	1.3
Unknown	0.5	1.3
Juveniles	12.2	1.9
Male	4.3	1.3
Female	7.1	2.0
Unknown	0.8	0.9
Pups	22.8	6.9
Male	6.9	2.2
Female	14.1	3.9
Unknown	1.8	1.3
Non-pup total	79.5 [a]	8.6
Grand total	102.3 [a]	13.6

[a] Total includes some seals which were not placed in any size class.

Table 2.2.--Composition of the Hawaiian monk seal subpopulation at French Frigate Shoals during the spring and summer of 2003. These numbers are an unknown portion of the entire subpopulation. Includes all known parturient females and pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	69	100	0	169	0.7:1
Subadults	14	12	0	26	1.2:1
Juveniles	17	26	0	43	0.6:1
Pups	20[a]	29[a]	3	52[a]	0.7:1
Non-pup Total	100	138	0	238	0.7:1
Grand Total	120	167	3	290	0.7:1

[a] Includes one male and one female perinatal dead pup; neither was seen alive.

Table 2.3.--Summary of tagged known-age seals born at French Frigate Shoals and resighted at any location in 2003.

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1984	19	Male	49	6[a]
		Female	43	9[a]
1985	18	Male	48	3[a]
		Female	38	8[a]
1986	17	Male	52	6[a]
		Female	48	16[a]
1987	16	Male	55	5
		Female	51	5
1988	15	Male	52	4
		Female	62	5
1989	14	Male	51	5
		Female	50	5[a]
1990	13	Male	38	1
		Female	41	6[a]
1991	12	Male	24	1
		Female	44	4[a]
1992	11	Male	36	2
		Female	55	9[a]
1993	10	Male	40	3
		Female	39	2
1994	9	Male	47	1
		Female	48	7[a]
1995	8	Male	29	2
		Female	26	11[a]
1996	7	Male	39	3
		Female	30	3
1997	6	Male	32	1
		Female	19	0
1998	5	Male	49	4
		Female	39	4

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1999	4	Male	30	7
		Female	30	4
2000	3	Male	27	2
		Female	30	4
2001	2	Male	21	4
		Female	19	5
2002	1	Male	25	13
		Female	28	21

[a] Cohort survivors include seals removed from French Frigate Shoals for rehabilitation or direct translocation. These seals were either released at Kure or Midway Atoll (n = 15) or taken into permanent captivity (n = 12).

Table 2.4a.--Summary of Hawaiian monk seals born at French Frigate Shoals in 2003.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	20	29	3	52
Died/probably died prior to weaning	3	2	2	7
Disappeared, suspected dead prior to weaning	2	1	0	3
Weaning status unknown	1[a]	1[b]	1[a]	3
Weaned	14	25	0	39
Tagged	12[c]	25	0	37[c]

[a] Pup disappeared at or near weaning.
[b] Pup was nursing on Trig Island at the end of the NMFS field camp and was not seen during USFWS autumn seal tagging efforts.
[c] Two male weaned pups were not tagged due to their compromised conditions (one likely blind, one sustained hindflipper amputations.

Table 2.4b.--Summary of nursing periods and measurements of weaned pups at French Frigate Shoals in 2003. Nursing periods were calculated where birth and weaning dates were both known or occurred within a range of 4 days or less. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	37.0	102.6	123.6
St. Dev.	3.4	10.3	6.6
n	28	35	35

Table 2.5a.--Documented movement of Hawaiian monk seals to French Frigate Shoals from other locations in 2003, summarized by movements between two locations. One seal made more than one documented trip.

Original location	Number of trips, size, and sex class
Laysan Island	3 adult female

Table 2.5b.--Documented movement of Hawaiian monk seals from French Frigate Shoals to other locations in 2003, summarized by movements between two locations. No seals made more than one documented trip.

Destination	Number of trips, size, and sex class
Laysan Island	2 adult female

Table 2.6.--Factors affecting Hawaiian monk seal survival at French Frigate Shoals in 2003.

Size	Sex	Total	Outcome		
			Injured	Died	Probably
Attack by Large Shark					
Adult	Male	2	2[a]	0	0
	Female	4[b]	4	0	0
Juvenile	Male	1	1	0	0
Nursing pup	Male	1	1[c]	0	0
	Female	1	0	1[d]	0
Mounting					
Weaned pup	Female	1[e]	0	0	0
Entanglement					
Adult	Female	1[f]	0	0	0
Subadult	Male	1[g]	0	0	0
Weaned pup	Female	1[f]	0	0	0
Emaciated					
Adult	Male	2	0	1	1
Juvenile	Female	1	0	1[h]	0
Unknown					
Adult	Female	1	1[i]	0	0
Juvenile	Female	1	0	1[j]	0
Nursing pup	Male	3	0	1[k]	2[l]
	Female	1	0	1[k]	0
	Unknown	2	0	0	2[l]

[a]One seal was in poor condition and seen only once during the season, on May 25.
[b]USFWS personnel documented one injury in January, prior to field season, and one injury after the field season in October. The female with the January injury aborted a fetus three weeks later; it is unknown if this is related to the injury.
[c]Shark bitten nursing pup at Round Island, entire left hindflipper and most of the right hindflipper amputated.
[d]Found dead at Little Gin Island, torso only.

[e]This incident, disrupted by observers, and two harassments (of a male and female weaned pup) were witnessed on East Island, all involving the same adult male aggressor (ID number Y1AO). No injuries, or very minor injuries, were observed following these incidents.
[f]Seals freed themselves uninjured after brief entanglement; nursing mom with a net/line and a weaned pup with a rubber ring.
[g]Released uninjured by USFWS personnel prior to field season.
[h]Found dead on Little Gin by USFWS personnel 2 days prior to start of field season.
[i]Open gash on top of head. Received injury prior to field season, reported by USFWS personnel.
[j] Found dead on East island by USFWS personnel prior to field season.
[k]One neonate pup death, not seen alive.
[l]Shark inferred mortality.

CHAPTER 3. THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 2003

Karen J. Holman, Catherine Gunther-Murphy,
Jennifer L. Palmer, and Laura J. Boren

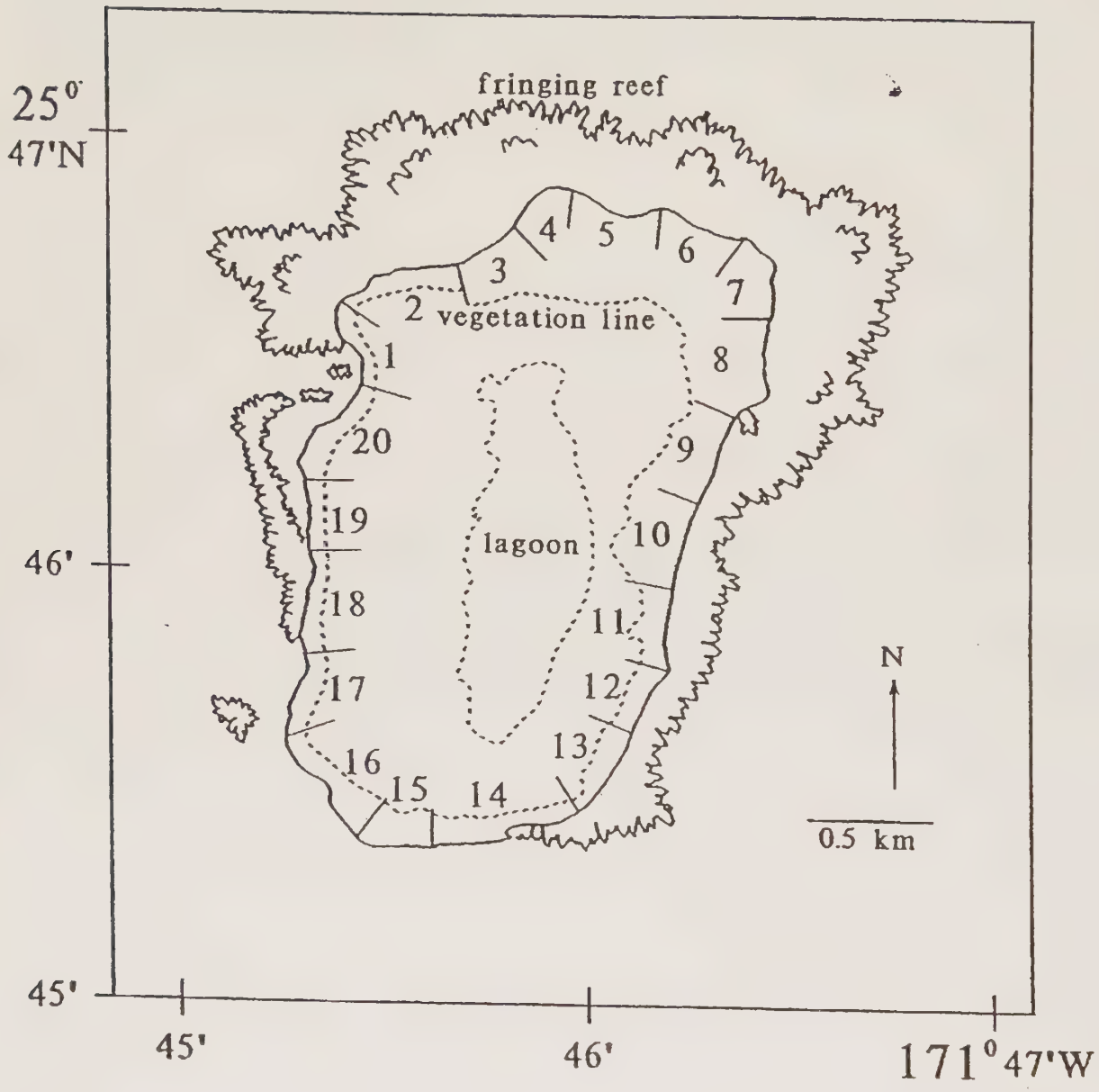

Fig. 3.1 Laysan Island in the Northwestern Hawaiian Islands.

Laysan Island (lat. 25°42' N, long. 171°44' W) is located ca. 1,300 km northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1). This island lies within the Hawaiian Islands National Wildlife Refuge and is one of the six primary haulout and pupping locations of the Hawaiian monk seal (Fig. 3.1).

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Laysan Island in 1981. In 2003, research was conducted by NMFS during March 7–July 20, and incidental observations were recorded by U.S. Fish and Wildlife Service (USFWS) personnel during the remainder of the year. The perimeter of the island (ca. 11 km) was divided into 20 sectors using artificial or natural landmarks (Fig. 3.1). Research objectives specific to this subpopulation in 2003 included (1) assessment of maternity and pup exchanges; and (2) documentation of male behavior, including aggression.

Censuses and Patrols

Censuses and patrols were scheduled to ensure that the entire island perimeter was monitored at least once daily during March 10–July 20. Censuses ($n = 28$) were conducted by two observers every fourth day from March 25 to July 15, beginning at 1300 Hawaii Standard Time and continuing for 2.2 to 4.4 h.

Standardized behavior patrols were conducted on non-census days from March 27 to July 9 to assess activity patterns of adults and large subadults and document male aggression. During these patrols ($n = 23$), attention was directed out to sea as much as possible since multiple male aggression has been observed most frequently in the water. Full-island standardized incidental surveys ($n = 66$) were conducted on non-census and non-behavior patrol days to record female and pup pairs, factors affecting survival, weaned pups, and molting animals. Additional partial island surveys were conducted as needed.

Individual Identification

A total of 277 individuals (244 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Bleach marks were applied to 180 seals, including 29 nursing pups. All pups weaned by the end of the field season ($n = 26$)

were tagged with Temple Tags and most (n = 25) received passive integrated transponder (PIT) tags. A total of six yearlings were newly tagged and received PIT tags. In addition, one 2-year-old seal and two weaned pups were retagged with temple tags to replace broken or lost tags.

Collection of Samples

One hundred-six scat and two spew samples were collected. Skin punches were collected from 26 weaned pups, 6 yearlings, and a 2-year-old seal. In addition, one tissue sample was collected from an adult female with a severed lobe of the left hind flipper. Shed molt samples were collected from 36 individuals. Fresh placentas were collected from three births. Necropsies were performed, and tissue samples collected, from four recently dead seals. Skulls were collected from two of these seals. One seal torso was found washed up, consisting mainly of rotted blubber and skeletal remains. A tissue sample and vertebrae were collected. Potentially entangling marine debris was collected from beaches and stored in a secure location pending removal. One piece of fine rope was removed and collected from an entangled seal.

Noteworthy Events

Human Intervention

Human intervention promoted the survival of nursing and weaned pups in potentially life-threatening situations, including one premature weaning, two mother-pup separations, and two incidents of male aggression.

In the case of premature weaning, a female pup was involved in a pup switch on the day of her birth and began nursing an adult female that had already completed 25 days of nursing. When the pup was prematurely weaned from her foster mother after only 24 days of nursing, she was returned to her birth mother in a human-assisted pup exchange. The prematurely weaned pup was returned to her birth mother, displacing a female pup in excellent condition after having completed a 41-day nursing period. Subsequently, the pup returned to her mother nursed an additional 10 days.

In the first mother-pup separation, a 3-day-old male pup was observed alone and vocalizing at the shoreline, approximately 200 m away and out of line of sight from his sleeping mother. The pup was successfully reintroduced to his birth mother, completed a full nursing period, and subsequently weaned. A second male pup was abandoned by his mother on the day of his birth: first for a period of at least 4.5 h and secondly, for approximately 12 h. In the first instance, the mother, attended by an adult male, returned to her pup independently and no human intervention was necessary. During her second

departure, however, the pup was monitored by researchers overnight and repeatedly coaxed from the shallow water. The mother was sighted the following day approximately 300 m away and researchers successfully reintroduced the pair, resulting in a full nursing period without interruption.

Following weaning, however, this latter pup was observed repeatedly interacting with an adult male and two incidents of targeted, sustained male aggression were disrupted by researchers. During these incidents the adult male was mildly biting the weaned pup's posterior and forcing the weaned pup underwater for prolonged periods of time (> 2 minutes). Researchers repeatedly deterred the adult male in two separate incidents through arm-waving and shouting. Although the male repeatedly returned to the weaned pup after initial interventions, the weaned pup and adult male were not observed in association again for the remainder of the season (44 days) after the last human intervention.

RESULTS

Subpopulation Minimum Abundance and Composition

The mean (± SD) of 28 censuses was 88.4 seals (± 14.0) including pups, and 73.7 seals (± 12.9) excluding pups (Table 3.1). The total spring-summer minimum subpopulation was 272 individuals, 239 excluding pups (Table 3.2). This number is a subset of the total identified in the calendar year. The overall adult sex ratio was at 0.8:1 (65 males: 78 females). The numbers of tagged known-age seals born at Laysan Island during the period from 1983 to 2002, and resighted at any location in 2003, are summarized in Table 3.3.

Reproduction

At least 33 pups were born at Laysan Island in 2003: 29 were successfully weaned, 3 died/probably died prior to weaning, and weaning status of 1 pup was unknown because it disappeared at/near weaning (Table 3.4a). Three pups were still nursing at the end of the NMFS field season (all of which subsequently weaned) and one pup (of unknown weaning status) was born afterwards. Nursing periods and measurements of weaned pups are summarized in Table 3.4b. The birth rate measured as the number of pups born divided by the number of adult-sized females in the subpopulation x 100 was 42.3% ((33/78) x 100). A minimum of 21 pup exchanges occurred between 12 nursing females; four of these incidents were observed. One birth was observed, and a fostering led to an unusually long nursing duration of 76 days when a pup who initially weaned at 35 days began nursing an adult female whose pup had recently disappeared.

Interatoll Movement

Interatoll movement was documented for 18 seals that completed a total of 30 movements between Laysan Island and either French Frigate Shoals or Lisianski Island (Tables 3.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by male Hawaiian monk seals, entanglement in marine debris, and other/unknown factors led to 15 life-threatening conditions, which resulted in the confirmed deaths of 5 animals and the probable deaths of 1 adult female and 1 nursing pup (Table 3.6). Incidents of prolonged adult male aggression towards a weaned pup were observed and ceased after human intervention. Three adult females sustained male mounting injuries, leading to one confirmed death and one probable death. One seal was entangled around the neck with fine rope and released by observers. One male juvenile was found dead along a rocky shoreline. The seal was slightly thin, although not emaciated, and cause of death unknown. Two nursing pups (a male and female) died of unknown causes, and a seal torso was found washed up in a severely degraded condition. The torso consisted mainly of rotted blubber with one fore-flipper still attached. Judging from the size of the foreflipper, researchers suspect the carcass to be that of a juvenile or subadult. In addition to the cases summarized in Table 3.6, a pup disappeared near weaning at 19–36 days old and is suspected dead. It was first sighted on July 28 after the end of the NMFS field season and was last seen with its mother on August 15. The pup was missing by August 26 and was not resighted on nine additional USFWS surveys through October 24. Two seals were observed with healed wounds from between-season shark bites, and five yearlings (2 males and 3 females) were observed with unusual pelage conditions.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff and thank the captain and crew members of *The American Islander* and the NOAA ship, *The Oscar Elton Sette*. Special thanks are extended to Brenda Becker for assisting with establishing the field camp and general orientation to the island and sharing her wealth of local knowledge with the field team. Special thanks are also extended to Jason Baker for his encouragement, and to the USFWS crew on Laysan including Kevin Payne, Matt Toomey, Melissa Roth, Chris Depkin, John Kellam, Stefan Kropidlowski, Greg McClelland, and Natalie and Tom Wilkie for their support and data collection.

TABLES
for Laysan Island

Table 3.1.--Summary statistics for censuses (n = 28) of Hawaiian monk seals at Laysan Island from March 25 to July 15, 2003.

Size/Sex	Mean number of individuals	Standard deviation
Adults	45.5	8.5
Male	19.8	5.9
Female	23.6	4.3
Unknown	2.1	2.2
Subadults	14.3	4.5
Male	6.7	2.0
Female	7.1	3.3
Unknown	0.5	0.6
Juveniles	13.9	4.5
Male	8.4	3.6
Female	5.4	1.8
Unknown	0.1	0.4
Pups	14.6	6.3
Male	4.4	2.9
Female	8.8	3.8
Unknown	1.5	1.5
Non-pup total	73.7	12.9
Grand total	88.4	14.0

Table 3.2.--Composition of the Hawaiian monk seal subpopulation at Laysan Island during the spring and summer of 2003. Includes all known parturient females and pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	65	78	0	143	0.8:1
Subadults	20	25	0	45	0.8:1
Juveniles	27	24	0	51	1.1:1
Pups	12	19	2	33	0.6:1
Non-pup total	112	127	0	239	0.9:1
Grand total	124	146	2	272	0.8:1

Table 3.3.--Summary of tagged known-age seals born at Laysan Island and resighted at any location in 2003.

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1983	20	Male	10	1
		Female	10	6
1984	19	Male	16	2
		Female	13	4
1985	18	Male	16	1
		Female	14	3
1986	17	Male	15	0
		Female	17	2
1987	16	Male	13	3
		Female	15	3
1988	15	Male	23	5
		Female	17	2
1989	14	Male	16	2
		Female	13	1
1990	13	Male	7	2
		Female	9	2
1991	12	Male	18	7
		Female	13	3
1992	11	Male	18	2
		Female	14	3
1993	10	Male	23	4
		Female	14	4
1994	9	Male	18	7
		Female	29	7
1995	8	Male	16	7
		Female	21	8
1996	7	Male	23	7
		Female	21	10

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1997	6	Male	19	5
		Female	16	7
1998	5	Male	24	12
		Female	20	9
		Unknown	1	0
1999	4	Male	20	8
		Female	34	18
2000	3	Male	14	2
		Female	20	2
2001	2	Male	16	8
		Female	17	10
2002	1	Male	21	19
		Female	16	14

Table 3.4a.--Summary of Hawaiian monk seals born at Laysan Island in 2003.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	12	19	2	33[a,b]
Died/Probably died prior to weaning	1	1	1	3
Weaning status unknown	0	0	1	1[a]
Weaned	11	18	0	29[b]
Tagged	10	18	0	28

[a] A pup suspiciously disappeared at 19–36 days old.

[b]Three pups, still nursing after the NMFS field season, subsequently weaned and were bleached by USFWS personnel. Two of these pups (both females) were tagged in 2004 whereas the third pup (a male) was not.

Table 3.4b.--Summary of nursing periods and measurements of weaned pups at Laysan Island in 2003. Nursing periods were calculated where both birth and weaning date ranges were ≤ 4 d. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	37.4[a]	101.5	123.9
Standard deviation	9.1	8.9	5.0
n	26	26	26

[a]Includes one pup who was initially weaned at 35 days and then began nursing an adult female with a recently disappeared pup before weaning a second time at 76 days (including a 6-day break between the two nursing periods).

Table 3.5a.–Documented movement of Hawaiian monk seals to Laysan Island from other locations in 2003, summarized by movements between two locations. One seal made more than one documented trip.

Original location	Number of trips, size, and sex class
French Frigate Shoals	2 adult female
Lisianski Island	2 adult male 8 adult female

Table 3.5b.–Documented movement of Hawaiian monk seals from Laysan Island to other locations in 2003, summarized by movements between two locations. Two seals made more than one documented trip.

Destination	Number of trips, size, and sex class
French Frigate Shoals	3 adult female
Lisianski Island	3 adult male 10 adult female 2 subadult female

Table 3.6.--Factors affecting Hawaiian monk seal survival at Laysan Island in 2003.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
		Attack by Large Shark			
Adult	Male	1	1	0	0
	Female	1	1	0	0
Juvenile	Male	1	1	0	0
	Female	1	1	0	0
		Mounting by Males			
Adult	Female	3	1	1[a]	1[b]
Weaned pup	Male	1[c]	0	0	0
		Entanglement			
Subadult	Male	1[d]	0	0	0
		Other/Unknown			
Adult	Male	1	1	0	0
Juvenile	Male	1	0	1[e]	0
Nursing pup	Male	1	0	1[f]	0
	Female	1	0	1[g]	0
	Unknown	1	0	0	1[h]
Immature	Unknown	1	0	1[i]	0

[a] Seal found dead underwater with a severe mounting injury.

[b] Seal sustained severe mounting injuries. She was lethargic and remained in the same location until she disappeared 48 days before the NMFS field camp ended.

[c] Escalating incidents of sustained targeted male aggression were observed between the same adult male and pup from 6/03 to 6/08. Aggressive interactions ceased following human interventions on 6/07 and 6/08.

[d] Seal was found with a thin grey rope embedded around it's neck, and was released by researchers. The seal sustained a minor injury.

[e] Juvenile found dead along rocky shoreline, cause of death unknown. Seal slightly thin but not emaciated.

[f] Pup found dead underwater, cause of death unknown.

[g] Pup found dead on beach, cause of death unknown.

[h] A pup disappeared and probably died at 9-10 days old, and it's mother was observed patrolling shores and vocalizing for her lost pup.

[i] A severely degraded torso washed up on beach, consisting of blubber with the left front flipper still attached. No organs remained. The size of the foreflipper was consistent with a juvenile or subadult seal.

CHAPTER 4. THE HAWAIIAN MONK SEAL ON LISIANSKI ISLAND, 2003

Maia N. Yannacone, Shawn C. Farry, Stori C. Oates, and Tracy A. Wurth

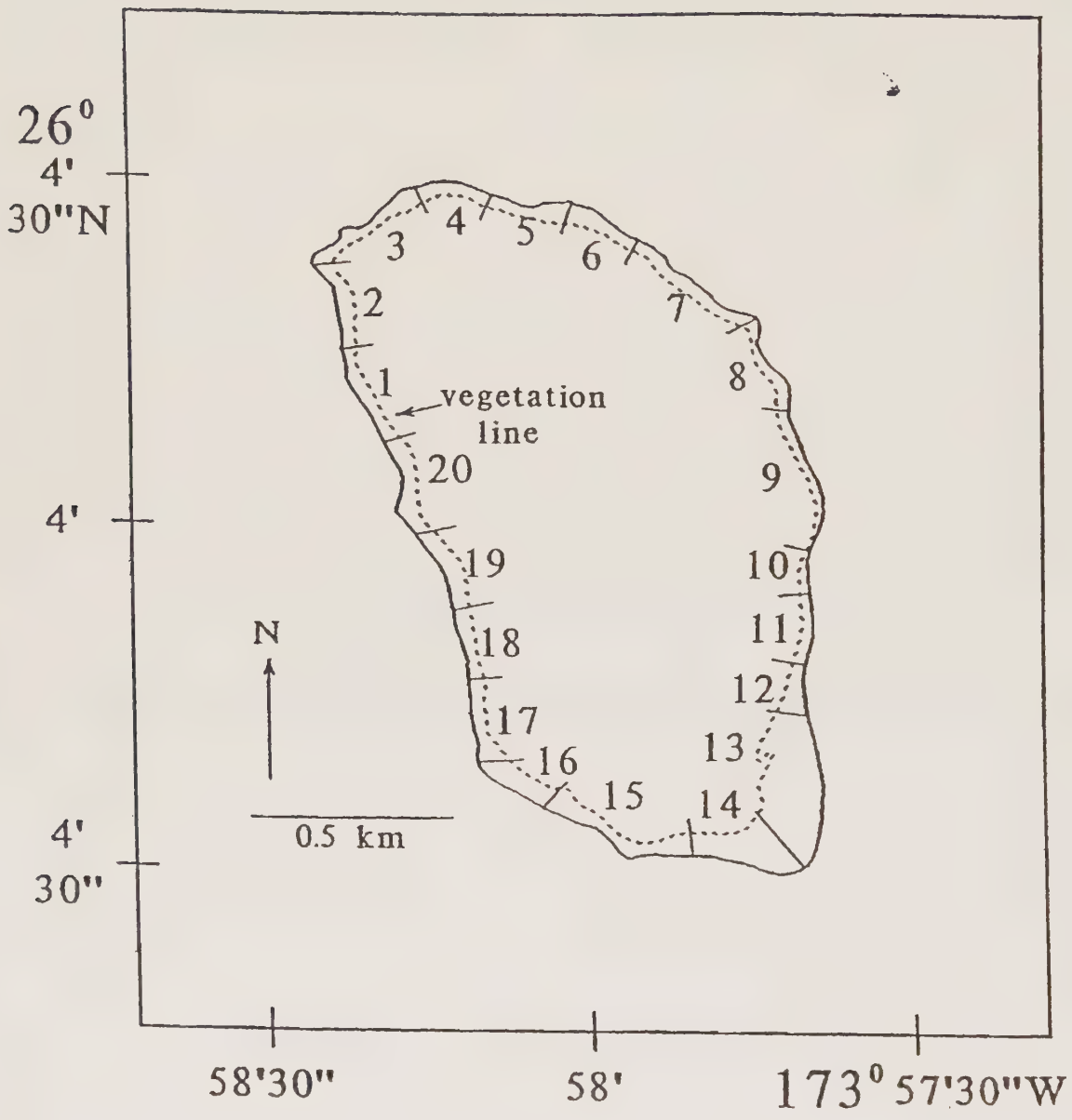

Fig. 4.1 Lisianski Island in the Northwestern Hawaiian Islands.

Lisianski Island (lat. 26°02' N, long. 174°00' W) is one of the primary haulout and pupping locations of the Hawaiian monk seal. The island is located ca. 1,760 km northwest of Oahu (Fig. 1.1) and is situated in Neva Shoal, a shallow reef bank within the Hawaiian Islands National Wildlife Refuge (Fig. 4.1).

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Lisianski Island in 1980. In 2003 research was conducted by NMFS during March 10–July 16. The perimeter of the island was divided into 20 sectors using artificial or natural landmarks (Fig. 4.1). Research activities specific to this subpopulation in 2003 included (1) assessment of maternity and pup exchanges; and (2) documentation of adult male behavior and aggression, including focal observations in areas frequented by weaned pups.

Censuses and Patrols

Censuses and patrols were scheduled to ensure that the entire island was monitored at least once daily during March 10–July 13. Censuses (n = 25) were conducted by two observers every fourth day from April 2 to July 9, beginning at 1300 Hawaii Standard Time and continuing from 1.2 to 2.4 h.

Standardized behavior patrols were conducted on non-census days to assess activity patterns of adults and large subadults and document male aggression. During these patrols (n = 21), attention was directed out to sea as much as possible since multiple male aggression has been observed most frequently in the water. Full-island standardized incidental surveys (n = 79) were conducted on non-census and nonbehavior patrol days from March 10 to July 13 to record female and pup pairs, factors affecting survival, weaned pups, and molting animals. Additional partial island surveys were conducted as needed.

Individual Identification

A total of 184 individuals (156 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 26) were tagged with Temple tags and passive integrated transponder (PIT) tags.

Collection of Samples

Ninety-nine scat samples were collected. Skin punches were collected from 26 seals during tagging and from three dead pups (2 nursing and 1 weaned) during necropsies. Necropsies were performed and tissue samples were collected from two male nursing pups and one female weaned pup. Skeletal samples were collected from all three seals. One dead yearling was found at the beginning of the season and was partially decomposed; tags were removed from this individual. Two placentas were collected. Thirty-six shed molt samples were collected from 36 individuals, and one eel cone was removed from a male weaned pup's muzzle and also collected. Potentially entangling marine debris was collected from beaches and stored in a secure location pending removal.

Special Studies

Male Aggression Towards Weaned Pups

Focal observations of sectors frequented by weaned pups were conducted intermittently from May 15 to June 20, with researchers noting any aggressive male behavior and intervening as needed when life-threatening situations arose. Three incidents of targeted, sustained male aggression were observed. A female-weaned pup was found dead in the surf zone with an adult biting her back, assuming a copulatory posture, and holding her head underwater. On two separate occasions, male-weaned pups were similarly harassed, bitten on the dorsum and held underwater; both incidents were disrupted by researchers. One pup developed multiple abscesses and the other only sustained superficial lacerations. All three incidents involved different male aggressors.

Noteworthy Events

Human Intervention

Two of the single, male aggression incidents noted above were disrupted by researchers. One successful human-assisted pup switch was initiated by researchers reuniting two mothers with their birth pups. Previous pup exchanges had resulted in one pup in a nursing association with a foster mother, while the pup's birth mother (and the foster mother's pup) remained alone. The nursing female pup was removed from her foster mother and was moved approximately 10 meters to her birth mom who was alone and searching for her. The other male pup, who was found without a female a few meters from his birth mother, was then able to reunite with his birth mother once she was alone.

RESULTS

Subpopulation Minimum Abundance and Composition

The mean (± SD) of 25 censuses was 67.3 seals (± 8.3) including pups, and 51.8 seals (± 7.1) excluding pups (Table 4.1). The minimum spring-summer subpopulation was 177 individuals, 149 excluding pups (Table 4.2). This number is a subset of the total identified during the calendar year. The overall adult sex ratio was at 1.2:1 (60 males:49 females). The numbers of tagged known-age seals born at Lisianski Island during the period from 1982 to 2002, and resighted at any location in 2003, are summarized in Table 4.3.

Reproduction

A minimum of 28 pups were born at Lisianski Island in 2003: 26 were successfully weaned and 2 died prior to weaning (Table 4.4a). Nursing periods and measurements of weaned pups are summarized in Table 4.4b. The birth rate, measured as the number of pups born divided by the number of adult-sized females in the subpopulation x 100 was 57.1% ((28/49) x 100). A minimum of 29 pup exchanges occurred among 15 nursing females. One human-assisted pup exchange reunited two birth mothers with their pups.

Interatoll Movement

Interatoll movement was documented for 17 seals that completed a total of 27 movements between Lisianski Island and either Laysan Island, Kure Atoll, or Maro Reef. An adult male from Lisianski Island (ID number GT24), videotaped at Maro Reef by researchers on board a deep-sea submersible on October 5 at 536 m depth, was identified by his bleach number (Terry Kerby, personal communication[2]) (Tables 4.5a and b). Another seal, observed on the same dive at 483 m depth, remains unidentified and is not included in the total.

Factors Affecting Survival

Attacks by large sharks, mounting attempts by male Hawaiian monk seals, entanglement in marine debris, emaciation, and other/unknown factors led to 13 life-threatening conditions, which resulted in the confirmed deaths of 4 animals and the probable deaths of 3 others (Table 4.6). Two entangled seals were successfully freed, one

[2]Submersible pilot and operations director, onboard RV *Ka'imikai-o-Kanaloa*.

male weaned pup with an eel cone on its muzzle and one female juvenile with net around her neck. The second seal was partially released by researchers and completely freed herself after escape from restraint. Adult male harassment of two male weaned pups resulted in one of those weaned pups developing multiple abscesses on his dorsum presumably from seal bites. One female weaned pup was found dead in the water with an adult male who was biting her and assuming a copulatory posture. Cause of death was probable drowning; no signs of trauma other than superficial lacerations and a missing nail on the right foreflipper were noted. One newborn male pup was found dead in the surf zone with his mom approximately 5 meters away being attended by an adult male. A small hematoma was found on the skull; however, cause of death is unknown.

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TABLES
for Lisianski Island

Table 4.1.--Summary statistics for censuses (n = 25) of Hawaiian monk seals at Lisianski Island from April 2 to July 9, 2003.

Size/Sex	Mean number of individuals	Standard deviation
Adults	40.0	5.9
Male	19.0	3.8
Female	18.8	3.5
Unknown	2.2	1.7
Subadults	6.4	2.8
Male	3.7	2.3
Female	2.6	1.2
Unknown	0.1	0.4
Juveniles	5.4	2.6
Male	3.1	1.6
Female	2.2	1.3
Unknown	0.1	0.3
Pups	15.5	4.1
Male	7.6	2.0
Female	7.8	2.4
Unknown	0.1	0.3
Non-pup total	51.8	7.1
Grand total	67.3	8.3

Table 4.2.--Composition of the Hawaiian monk seal subpopulation at Lisianski Island during the spring and summer of 2003. Includes all known parturient females and all pups born during the calendar year.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	60	49	109	1.2:1
Subadults	13	9	22	1.4:1
Juveniles	9	9	18	1.0:1
Pups	14	14	28	1.0:1
Non-pup total	82	67	149	1.2:1
Grand total	96	81	177	1.2:1

Table 4.3.--Summary of tagged known-age seals born at Lisianski Island and resighted at any location in 2003.

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1982	21	Male	7	2
		Female	6	0
1983	20	Male	6	1
		Female	18	7
1984	19	Male	10	4
		Female	5	1
1985	18	Male	5	1
		Female	9	1
1986	17	Male	11	5
		Female	9	2
1987	16	Male	12	1
		Female	6	1
1988	15	Male	10	5
		Female	8	6
1989	14	Male	--	--
		Female	--	--
1990	13	Male	8	3
		Female	9	3
1991	12	Male	9	4
		Female	6	2
1992	11	Male	13	6
		Female	8	4
1993	10	Male	4	2
		Female	9	2
1994	9	Male	4	1
		Female	5	0
1995	8	Male	7	2
		Female	10	2
1996	7	Male	9	2
		Female	13	1

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1997	6	Male	10	4
		Female	9	3
1998	5	Male	10	3
		Female	11	4
1999	4	Male	16	3
		Female	11	2
2000	3	Male	9	1
		Female	9	2
2001	2	Male	5	1
		Female	9	1
2002	1	Male	12	7
		Female	11	7

Table 4.4a.--Summary of Hawaiian monk seals born at Lisianski Island in 2003.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	14	14	0	28
Died prior to weaning	2	0	0	2
Weaned	12	14	0	26
Tagged	12	14	0	26

Table 4.4b.--Summary of nursing periods and measurements of weaned pups at Lisianski Island in 2003. Nursing periods were calculated where both birth and weaning date ranges were $\leq$ 4 days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	35.1	101.7	119.3
Standard deviation	3.5	11.4	7.4
n	25	25	26

Table 4.5a.--Documented movement of Hawaiian monk seals to Lisianski Island from other locations in 2003, summarized by movements between two locations. One seal made more than one documented trip.

Original location	Number of trips, size, and sex class
Laysan Island	3 adult male 10 adult female 2 subadult female
Kure Atoll	1 juvenile male

Table 4.5b.--Documented movement of Hawaiian monk seals from Lisianski Island to other locations in 2003, summarized by movements between two locations. One seal made more than one documented trip.

Destination	Number of trips, size, and sex class
Laysan Island	2 adult male 8 adult female
Maro Reef	1 adult male

Table 4.6.--Factors affecting Hawaiian monk seal survival at Lisianski Island in 2003.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
Attack by Large Shark					
Adult	Female	1	0	0	1[a]
Subadult	Male	1	1	0	0
Juvenile	Female	1	1	0	0
Mounting by Male					
Weaned pup	Male	2[b]	1	0	0
	Female	1	0	1[c]	0
Entanglement					
Juvenile	Female	1[d]	0	0	0
Weaned pup	Male	1[e]	0	0	0
Emaciation					
Juvenile	Male	1	0	0	1
	Female	1	0	0	1
Other/Unknown					
Juvenile	Male	1	0	1	0
Nursing pup	Male	2	0	2	0

[a] Seal was in medium/thin condition when last sighted prior to attack.
[b] Two observed incidents of single adult male aggression were interrupted by researchers. One pups developed abscesses whereas the other only sustained superficial lacerations.
[c] A dead pup was observed being mounted repeatedly by a single adult male.
[d] Seal released by researchers.
[e] Seal partially released by researchers freed herself completely after escape from restraint.

CHAPTER 5. THE HAWAIIAN MONK SEAL ON PEARL AND HERMES REEF, 2003

Chad H.Yoshinaga, Maire K. Cahoon, and Jason D. Baker

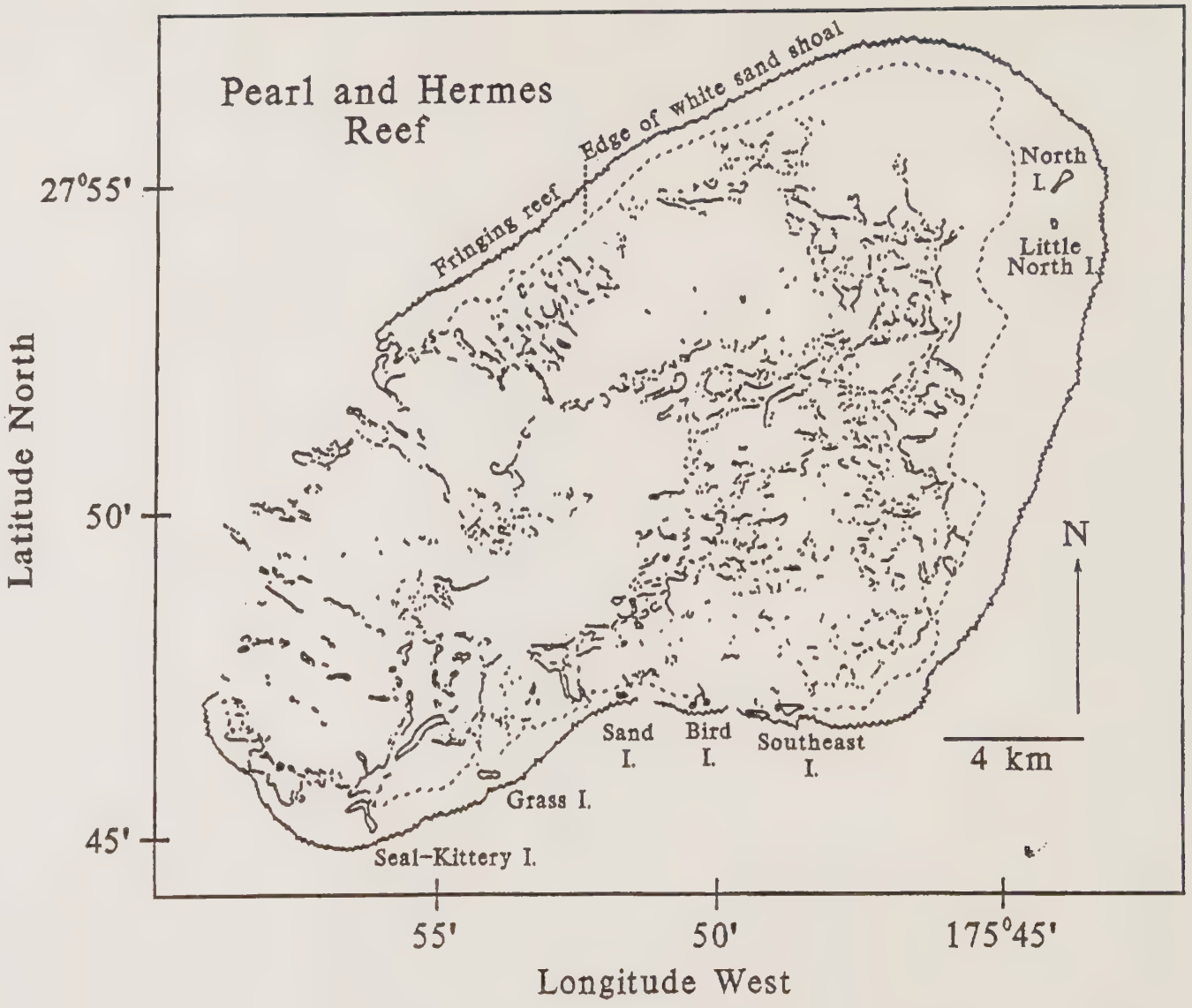

Fig. 5.1 Pearl and Hermes Reef in the Northwestern Hawaiian Islands.

Pearl and Hermes Reef (lat. 27°55' N, long. 175°45' W) is one of the primary haulout and pupping locations of the Hawaiian monk seal. This atoll is located ca. 1,900 km northwest of Oahu in the Northwestern Hawaiian Islands and is part of the Hawaiian Islands National Wildlife Refuge (Fig. 1.1). Pearl and Hermes is composed of four vegetated and three nonvegetated sand islets enclosed in a barrier reef (Fig. 5.1).

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Pearl and Hermes Reef in 1982. In 2003, research was conducted by NMFS on March 9, and during May 20–August 3. The perimeters of the four larger vegetated islets were divided into sectors using natural landmarks. Research activity specific to this subpopulation in 2003 included using kayaks to conduct opportunistic surveys of the north-northeast emergent reef to identify seals resting on the reef.

Censuses and Patrols

Atoll censuses ($n = 6$) were conducted every 10 days, on average, from May 31 to July 18. All islets were censused on foot by one or two persons. In addition, incidental surveys were conducted opportunistically to resight seals tagged in previous years and to identify and bleach-mark all animals in the subpopulation.

Individual Identification

A total of 211 individuals (181 excluding pups) were identified by existing or applied tags, scars, or natural markings. Twenty-four weaned pups were tagged with Temple Tags and passive integrated transponder (PIT) tags.

Collection of Samples

Twenty-nine scat and three spew samples were collected. Skin punches were collected from 18 seals during tagging. One complete adult female skeletal sample was collected in addition to two pup skulls. Additional samples were collected opportunistically, including 100 bird ticks and 3 placenta samples. Potentially entangling marine debris was collected from beaches and stored in a secure location pending removal.

Special Studies

Emergent Reef Surveys

Three surveys of the north-northeast emergent reef were conducted June 7–July 29, and the total number of seals counted on each survey ranged from 4 to 9. In all, nine seals were identified resting on the reef (2 weaned pups, 2 juveniles, 2 subadults, and 3 adults), and two individuals were identified resting on the reef more than once. Although all nine seals were also observed elsewhere during standard surveys of the atoll, two male seals (a weaned pup and a juvenile) were only identified once each at another location (both at North Island).

RESULTS

Subpopulation Minimum Abundance and Composition

The mean (± SD) of 6 atoll censuses was 84.8 seals (± 15.5) including pups and 71.2 seals (± 13.5) excluding pups (Table 5.1). The total minimum spring-summer subpopulation was 207 individuals, 177 excluding pups (Table 5.2). This number is a subset of the total identified during the calendar year. The numbers of tagged known-age seals born at Pearl and Hermes Reef during the period from 1983 to 2002 and resighted at any location in 2003 are summarized in Table 5.3.

Reproduction

At least 30 pups were born at Pearl and Hermes Reef in 2003: 24 were successfully weaned, 4 died prior to weaning, and two were still nursing at the end of the research period (Table 5.4). The birth rate, measured as the number of pups born divided by the number of adult-sized females identified in the subpopulation x 100, was 44.8% ((30/67) x 100). Nursing periods and measurements of weaned pups are summarized in Table 5.4.

Interatoll Movement

Interatoll movement was documented for 10 seals that completed a total of 13 movements between Pearl and Hermes Reef and either Midway Atoll, or Kure Atoll (Tables 5.5a and b).

Factors Affecting Survival

Entanglement in marine debris and unknown factors led to seven life-threatening conditions, which resulted in the confirmed deaths of five seals (Table 5.6). A dead adult male was found on North Island, and four pups died, one each found on Southeast Island, North Island, Little North Island, and Seal Kittery Island. Two male seals (an adult and subadult) were disentangled from debris. In addition to the incidents presented in Table 5.6, the mummified carcass of an adult female, that died since the previous season, was found on Southeast, and an adult male that probably drowned a pup in 2002 (ID number BC25) was observed harassing a male weaned pup at Little North in 2003.

ACKNOWLEDGMENTS

We thank the captain, officers, and crew of the NOAA ship *Oscar Elton Sette*. We also acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff.

TABLES
for Pearl and Hermes Reef

Table 5.1.--Summary statistics for atoll censuses ($n = 6$) of the Hawaiian monk seal at Pearl and Hermes Reef from May 31 to July 18, 2003.

Size/Sex	Mean number of individuals	Standard deviation
Adults	54.0	9.3
Male	21.2	5.1
Female	24.5	4.6
Unknown	8.3	2.4
Subadults	11.2	3.7
Male	3.8	1.8
Female	7.2	2.2
Unknown	0.2	0.4
Juveniles	5.8	2.6
Male	3.7	2.1
Female	1.7	1.0
Unknown	0.5	0.5
Pups	13.7	3.8
Male	7.5	2.1
Female	5.7	1.9
Unknown	0.5	1.2
Non-pup total	71.2[a]	13.5
Grand total	84.8[a]	15.5

[a] Total includes some seals which were not placed in any size class.

Table 5.2.--Composition of the Hawaiian monk seal subpopulation at Pearl and Hermes Reef during the spring and summer of 2003. These numbers are an unknown portion of the entire subpopulation. The table includes all known parturient females and pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	62	67	3	132	0.9:1
Subadults	12	16	1	29	0.8:1
Juveniles	10	6	0	16	1.7:1
Pups	14	10	6	30	1.4:1
Non-pup total	84	89	4	177	0.9:1
Grand total	98	99	10	207	1.0:1

Table 5.3.--Summary of tagged known-age seals born at Pearl and Hermes Reef and resighted at any location in 2003.

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1983	20	Male	8	0
		Female	2	1
1984	19	Male	5	1
		Female	8	2
1985	18	Male	9	1
		Female	6	4
1986	17	Male	10	2
		Female	7	2
		Unknown	1	0
1987	16	Male	14	4
		Female	7	2
1988	15	Male	12	8
		Female	6	3
1989	14	Male	8	2
		Female	6	1
1990	13	Male	5	2
		Female	1	0
1991	12	Male	10	7
		Female	11	4
1992	11	Male	13	4
		Female	10	6
1993	10	Male	14	3
		Female	7	3
1994	9	Male	--	--
		Female	--	--
1995	8	Male	15	7
		Female	12	5
1996	7	Male	11	2
		Female	12	4

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1997	6	Male	16	8
		Female	11	3
1998	5	Male	8	4
		Female	21	11
1999	4	Male	11	4
		Female	15	4
2000	3	Male	12	6
		Female	10	2
2001	2	Male	16	2
		Female	9	2
2002	1	Male	16	4
		Female	6	2

Table 5.4a.--Summary of Hawaiian monk seals born at Pearl and Hermes Reef in 2003.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	14	10	6	30
Died prior to weaning	0	0	4	4
Weaning status unknown	0	0	2	2[a]
Weaned	14	10	0	24
Tagged	14	10	0	24

[a] Two pups were still nursing at the end of the NMFS field camp.

Table 5.4b.--Summary of nursing periods and measurements of weaned pups at Pearl and Hermes Reef in 2003. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	36.5	106.6	124.7
Standard deviation	1	12.8	9.4
n	3	15	15

Table 5.5a.--Documented movement of Hawaiian monk seals to Pearl and Hermes Reef from other locations in 2003, summarized by movements between two locations. No seals made more than one documented trip.

Original location	Number of trips, size, and sex class
Midway Atoll	1 adult male 3 adult female
Kure Atoll	2 adult male 1 adult female

Table 5.5b.--Documented movement of Hawaiian monk seals from Pearl and Hermes Reef to other locations in 2003, summarized by movements between two locations. No seal made more than one documented trip.

Destination	Number of trips, size, and sex class
Midway Atoll	4 adult female
Kure Atoll	1 adult male 1 adult female

Table 5.6.--Factors affecting Hawaiian monk seal survival at Pearl and Hermes Reef in 2003.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
Attack by Large Shark					
(none observed)					
Mounting by Males					
(none observed)					
Entanglement					
Adult	Male	1[a]	0	0	0
Subadult	Male	1[a]	0	0	0
Unknown					
Adult	Male	1	0	1	0
Nursing Pup	Unknown	4	0	4	0

[a]Seal released by observers.

CHAPTER 6. THE HAWAIIAN MONK SEAL AT MIDWAY ATOLL, 2003

Leona Laniawe and Misty Niemeyer

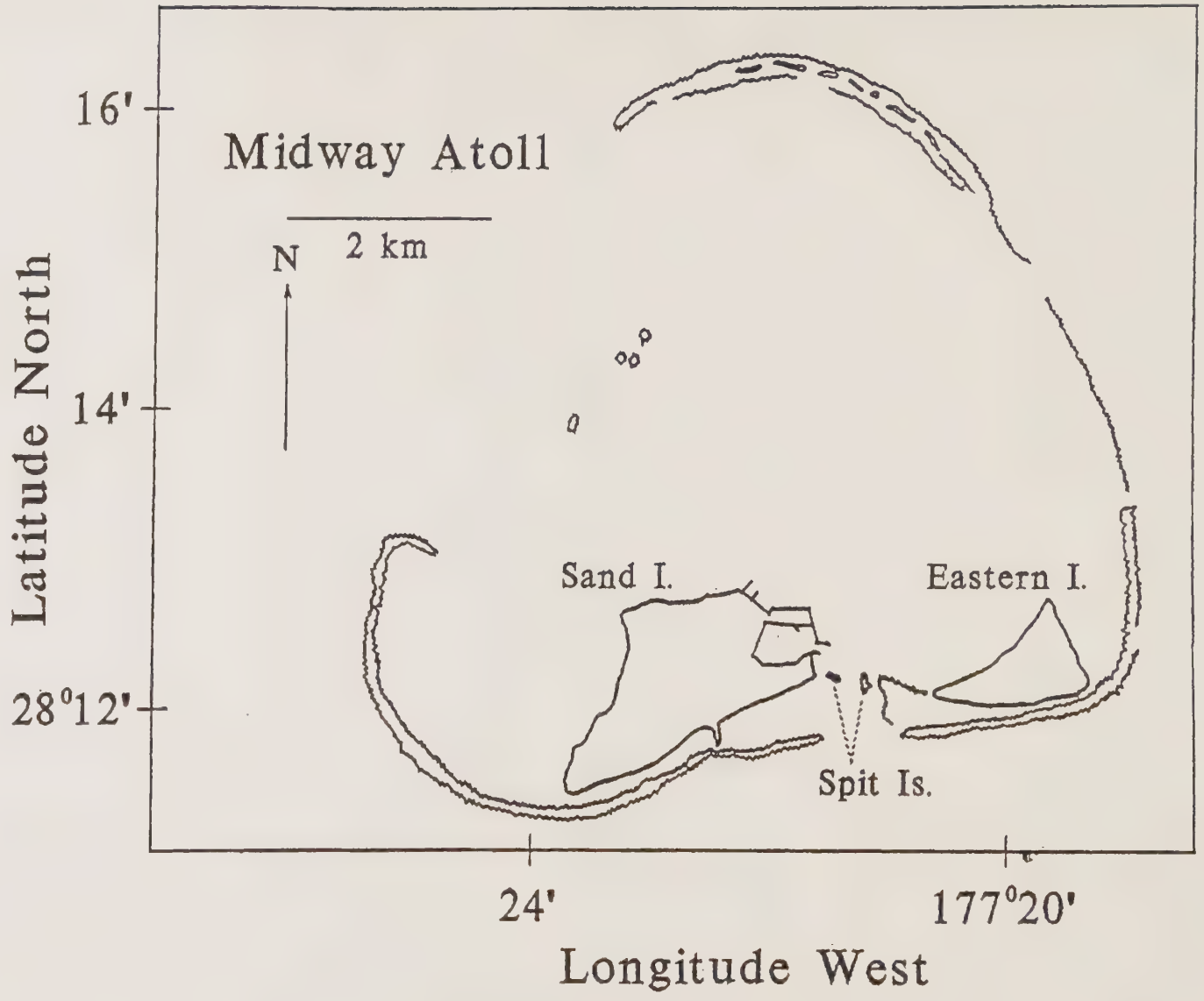

Fig. 6.1 Midway Atoll in the Northwestern Hawaiian Islands.

Midway Atoll (lat. 28°14' N, long. 177°22' W) is one of the primary haulout and pupping locations of the endangered Hawaiian monk seal. This atoll is located ca. 2,100 km northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1) and comprises a circular atoll approximately 9 km in diameter, enclosing a lagoon and three permanent islets (Fig. 6.1). Eastern and Spit Islands are uninhabited. Sand Island was the site of a U.S. Naval Air base from ca. 1939 until 1993. The U.S. Fish and Wildlife Service (USFWS) maintained an overlay refuge (Midway Atoll National Wildlife Refuge) at the site from 1988, until full authority was transferred to the USFWS in October 1996.

RESEARCH

The National Marine Fisheries Service (NMFS) began limited monitoring of Hawaiian monk seals at Midway Atoll in 1983. This effort was increased to year-round monitoring during 1997–1999 by collaborating researchers from Oceanic Society (OS) and Hawaii Wildlife Fund. In 2003, research was conducted by NMFS during May 24–July 18. Incidental observations were recorded by USFWS personnel during the rest of the year. Perimeters of the three permanent islets were divided into sectors using artificial or natural landmarks. Research activities specific to this subpopulation in 2003 included (1) emergent reef surveys to determine haulout patterns on these areas; (2) tissue and spew sampling for DNA, ciguatera survey, and foraging ecology studies; (3) survey for and removal of marine debris from the north and east reef flats, emergent reef areas, and along the shores of the atoll's three islets; and (4) monitoring human impacts on seals to quantify occurrence and potential effects on monk seal habitat usage.

Censuses and Patrols

Atoll censuses (n = 8) were conducted every 7th day, on average, from May 24 to July 7. All islets were censused on foot by one or two persons. Spit was occasionally surveyed by boat on severe weather days. Patrols of Sand Island (n = 15), Eastern (n = 22), or Spit (n = 26) were conducted on non-atoll census days during January 30–July 17.

Individual Identification

A total of 69 individuals (54 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Fifteen pups weaned at Midway and fourteen were tagged with Temple tags and passive integrated transponder (PIT) tags. One weaned pup was not tagged, due to health issues.

Collection of Samples

Skin punches were collected from 14 weaned pups during tagging. One spew, several ticks, 3 pieces of entangling debris, and 10 shed molt samples were collected. One necropsy was performed by cooperating scientists after the field season. Swab, blood, and fecal samples were collected from a prematurely weaned pup for health assessment purposes. Potentially entangling marine debris was collected from beaches and stored in a secure location pending removal.

Special Studies

Emergent Reef Surveys

Patrols were conducted twice during the field season along the emergent reef areas of the North Reef ($n = 2$), and East Reef ($n = 2$) on July 1 and July 8, 2003. Two people using kayaks and a motorboat surveyed the reefs for seals and turtles. On both occasions, the North and East emergent reef areas were surveyed within 1 day of atoll counts to provide an estimate of atoll-wide beach/emergent reef counts.

Noteworthy Events

Beach Monitoring and Public Education

From January to July 2003, Sand Island beaches and trails were monitored for approximately 10 h/week. Monk seal natural history was shared opportunistically with visitors and residents. Other actions taken to mitigate disturbance to seals included the posting of seal signs set approximately 50 yards away from the individual, informing people that a seal was in the area.

Prematurely weaned Pup Rehabilitation Project

On June 10, an undersized prematurely weaned pup was observed and tagged on Eastern Island. The female pup was later collected and rehabilitated from June 13 to July 16, 2003. On July 16, the pup was radio (VHF) tagged and released back on Eastern Island. The pup was last seen, in good condition, on November 5, 2003 and has not been seen since.

RESULTS

Subpopulation Minimum Abundance and Composition

The mean (± SD) of 8 atoll censuses was 25.9 seals (± 5.6) including pups, and 16.9 seals (± 4.1) excluding pups (Table 6.1). The minimum spring-summer subpopulation was 63 seals, 48 excluding pups (Table 6.2). This number is a subset of the total identified in the calendar year. The numbers of tagged known-age seals born at Midway Atoll during the period from 1988 to 2002, and resighted at any location in 2003, are summarized in Table 6.3.

Reproduction

A minimum of 15 pups were born at Midway Atoll in 2003, and all successfully weaned (Table 6.4a). The birth rate, measured as the number of pups born divided by the number of adult-sized females in the subpopulation x 100 was 62.5% ((15/24) x 100). A minimum of one pup exchange occurred between nursing females, resulting in one prematurely weaned female pup and one large male pup. Nursing periods and measurements of weaned pups are summarized in Table 6.4b.

Interatoll Movement

Interatoll movement was documented for 19 seals that completed a total of 30 movements between Midway Atoll and either Pearl and Hermes Reef or Kure Atoll (Tables 6.5a and b).

Factors Affecting Survival

Attacks by sharks, entanglement in marine debris, and other causes led to six life-threatening conditions, which resulted in the confirmed death of one individual (Table 6.6). One weaned male pup exhibited an unusually bloated body condition and was not observed on land post-weaning. In addition, green algae covered a large percentage of its body and he exhibited signs of discomfort upon an observed attempt to haul out onto a beach. This pup was later found dead and was necropsied. A defect was found in the chest wall and findings suggested nutritional panniculitis caused by eating dead, rancid fish, with bronchiopneumonia identified as the likely cause of death. Four seals were entangled in marine debris: a juvenile male escaped unaided, and three others (an adult female, a juvenile female, and a weaned female pup) were released by observers. In addition, one female weaned pup sustained a large shark related wound to the left side of her head.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service. Special thanks are extended to John Klavitter, Refuge Biologist; Mike Johnson, Assistant Refuge Manager; and Tim Bodeen, Refuge Manager. We also thank Dr. Robert Braun, Howard Rhinehart, and Michelle Caudle for their efforts in the preweaned pup rehabilitation and the officers and crew of the NOAA ship *Oscar Elton Sette* for logistical assistance.

TABLES
for Midway Atoll

Table 6.1.--Summary statistics for atoll censuses (n = 8) of Hawaiian monk seals at Midway Atoll from May 24 to July 7, 2003.

Size/Sex	Mean number of individuals	Standard deviation
Adults	10.4	3.6
Male	1.1	1.4
Female	8.4	3.2
Unknown	0.9	1.4
Subadults	4.3	0.9
Male	2.9	0.6
Female	1.1	0.6
Unknown	0.3	0.5
Juveniles	2.3	1.3
Male	0.4	0.5
Female	1.9	1.0
Unknown	0.0	0.0
Pups	9.0	2.4
Male	1.8	0.7
Female	3.5	1.4
Unknown	3.8	2.5
Non-pup total	16.9	4.1
Grand total	25.9	5.6

Table 6.2.--Composition of the Hawaiian monk seal subpopulation at Midway Atoll during the spring and summer of 2003. These numbers are an unknown portion of the entire subpopulation. Includes all known parturient females and pups born during the calendar year.

	Number of seals			
Size	Male	Female	Total	Sex ratio Male:Female
Adults	7	25	32	0.3:1
Subadults	8	3	11	2.7:1
Juveniles	1	4	5	0.2:1
Pups	6[a]	9	15	0.7:1
Non-pup total	16	32	48	0.5:1
Grand total	22	41	63	0.5:1

[a]Includes one untagged weaned pup, found dead in August 2003.

Table 6.3.--Summary of tagged known-age seals born at Midway Atoll and resighted at any location in 2003.

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1988	15	Male	0	NA
		Female	1	1
1989	14	Male	0	NA
		Female	0	NA
1990	13	Male	0	NA
		Female	0	NA
1991	12	Male	1	0
		Female	1	1
1992	11	Male	0	NA
		Female	1	1
1993	10	Male	1	0
		Female	0	NA
1994	9	Male	0	NA
		Female	0	NA
1995	8	Male	1	0
		Female	6	1
		Unknown	1	0
1996	7	Male	1	0
		Female	4	0
1997	6	Male	3	1
		Female	6	2
1998	5	Male	8	3
		Female	2	2
1999	4	Male	7	2
		Female	4	1
2000	3	Male	5	1
		Female	9	0
2001	2	Male	6	1
		Female	5	2
2002	1	Male	7	1
		Female	4	3

Table 6.4a.--Summary of Hawaiian monk seals born at Midway Atoll in 2003.

Event	Number of pups		
	Male	Female	Total
Born	6	9	15
Died prior to weaning	0	0	0
Weaned	6	9	15
Tagged	5[a]	9	14[a]

[a]One weaned male pup was not tagged, and later found dead.

Table 6.4b.--Summary of nursing periods and measurements of weaned pups at Midway Atoll in 2003. Nursing periods were calculated where both birth and weaning date ranges were ≤ 4 d. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	36.0	114.6	130.6
Standard deviation	--	11.7	7.8
n	1	9	9

Table 6.5a.--Documented movement of Hawaiian monk seals to Midway Atoll from other locations in 2003, summarized by movements between two locations. Two seals made more than one documented trip.

Destination	Number of trips, size, and sex class
Pearl and Hermes Reef	4 adult female
Kure Atoll	5 adult male 8 adult female

Table 6.5b.--Documented movement of Hawaiian monk seals from Midway Atoll to other locations in 2003, summarized by movements between two locations. No seals made more than one documented trip.

Destination	Number of trips, size, and sex class
Pearl and Hermes Reef	1 adult male 3 adult female
Kure Atoll	4 adult male 5 adult female

Table 6.6.--Factors affecting Hawaiian monk seal survival at Midway Atoll in 2003.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
Attack by Large Shark					
Weaned Pup	Female	1	1	0	0
Mounting by Males (none observed)					
Entanglement					
Adult	Female	1[a]	1	0	0
Juvenile	Male	1[b]	0	0	0
	Female	1[a]	0	0	0
Weaned pup	Female	1[a]	0	0	0
Other					
Weaned pup	Male	1[c]	0	1	0

[a] Seal released by researchers.
[b] Seal freed itself.
[c] Prior to death, the pup exhibited an unusually bloated body condition and was not observed on land post-weaning.

CHAPTER 7. THE HAWAIIAN MONK SEAL AT KURE ATOLL, 2003

Lizabeth S. Kashinsky and Robert D. Marshall

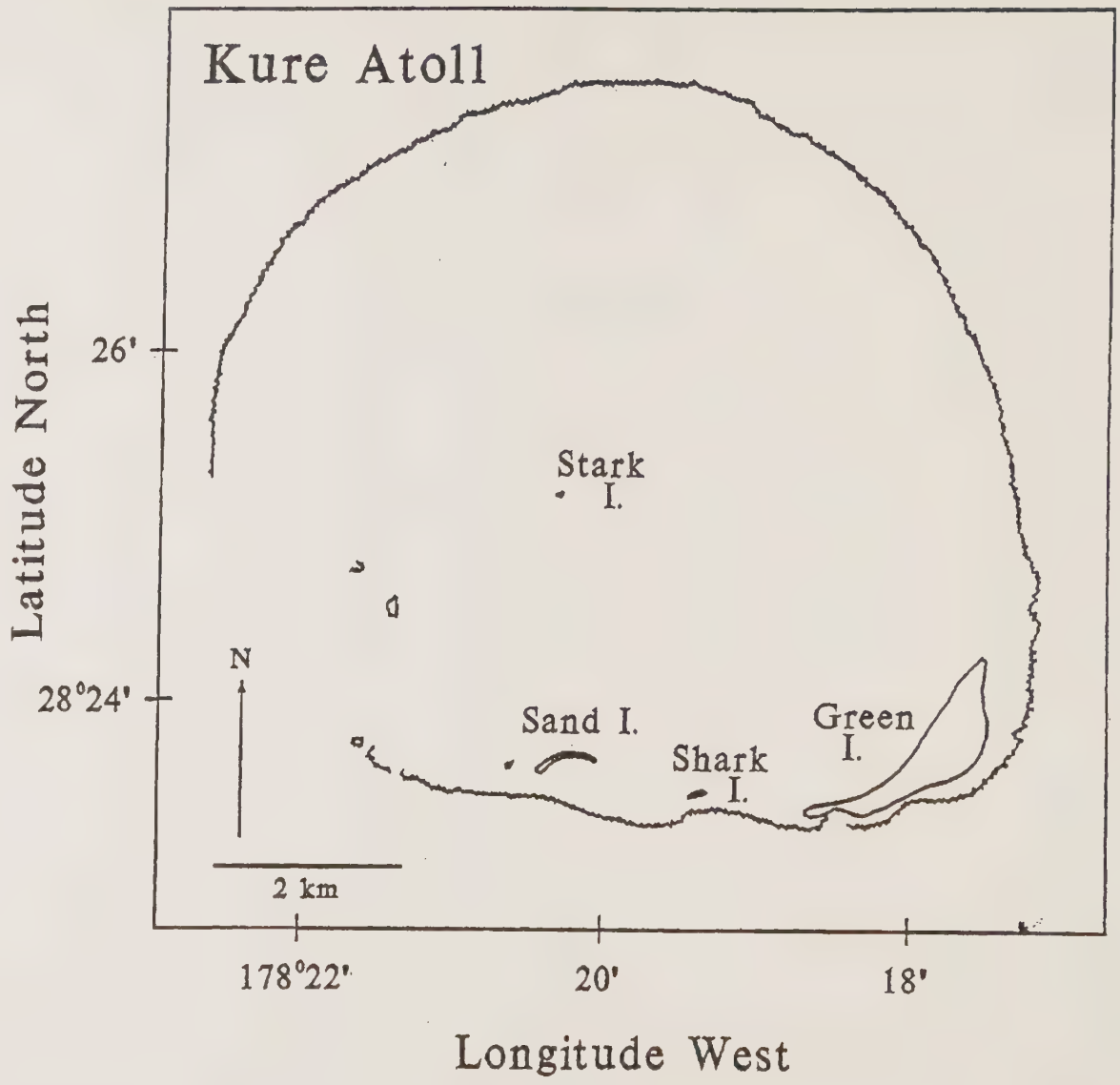

Fig. 7.1 Kure Atoll in the Northwestern Hawaiian Islands.

Kure Atoll (lat. 28°25' N, long. 178°10' W) is one of the primary haulout and pupping locations of the Hawaiian monk seal. The atoll is located ca. 2,300 km northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1) and is a seabird sanctuary of the State of Hawaii. The atoll consists of a circular fringing reef approximately 9 km in diameter, the enclosed lagoon, one permanent vegetated island (Green Island), two sand islets (Sand and Shark), and an ephemerally emergent area known locally as Stark Reef (Fig. 7.1). From 1960 to 1992, Green Island was the site of a U.S. Coast Guard (USCG) LORAN station, staffed by 20-30 USCG personnel. In July 1992, this station was closed and vacated by the USCG, leaving the atoll uninhabited. In 1993, the USCG completed the removal of most of the infrastructure on Green Island.

RESEARCH

National Marine Fisheries Service (NMFS) began research on the Hawaiian monk seal at Kure Atoll in 1981. In 2003, research was conducted by NMFS during May 24–July 14, and additional incidental observations were recorded by State of Hawaii personnel until September 23. The perimeter of Green Island was divided into eight sectors using artificial or natural landmarks.

Censuses and Patrols

Atoll censuses (n = 11) were conducted every twice weekly on average, from June 6 to July 14. All islets were censused on foot by one or two persons. Shark Islet and Stark Reef were not emergent during the 2003 field season. Patrols were conducted on non-atoll census days to identify seals and monitor locations used by parturient females. In total, 28 patrols of Green Island and 1 patrol of Sand Islet were conducted.

Individual Identification

A total of 103 individuals (85 excluding pups) was identified by existing or applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 18) were tagged with Temple Tags, and passive integrated transponder (PIT) tags were applied.

Collection of Samples

Twenty scat, three spew, and seven molt samples were collected. Skin punches were collected from 18 seals during tagging. One satellite-linked dive recorder (SLDR) that was applied to a seal in October–November 2001 was found on the beach and retrieved. Potentially entangling marine debris was collected from beaches and stored in a secure location pending removal. A large conglomerate of buried net remains within and near the *Paradise Queen II* wheel house on the east shore of Green Island. An unstable section of the deck and hull remains on the reef.

Noteworthy Events

Human Intervention

An adult male was observed in the water mounting a newly weaned female pup for several minutes. Human interference caused the adult male to back off, and the weaned pup immediately hauled out on the beach. No significant injuries were noted on the pup.

RESULTS

Subpopulation Minimum Abundance and Composition

The mean (± SD) of 11 atoll censuses was 46.5 seals (± 4.3) including pups, and 37.3 seals (± 4.5) excluding pups (Table 7.1). The minimum spring-summer subpopulation was 93 individuals, 75 excluding pups (Table 7.2). This number is a subset of the total identified in the calendar year. The numbers of tagged known-age seals born at Kure Atoll during the period from 1981 to 2002, and resighted at any location in 2003, are summarized in Table 7.3.

Reproduction

At least 18 pups were born at Kure Atoll in 2003, and all successfully weaned (Table 7.4a). Nursing periods and measurements of weaned pups are summarized in Table 7.4b.) The birth rate, measured as the number of pups born divided by the number of adult-sized females in the subpopulation x 100 was 54.5% (18/33 x 100). Six of the seven identified parturient females (85.7%) had either been temporarily maintained as pups in the Kure Atoll Head Start Project or rehabilitated from FFS.

Interatoll Movement

Interatoll movement was documented for 16 seals that completed a total of 28 movements between Kure Atoll and either Lisianski Island, Pearl and Hermes, or Midway Atolls (Table 7.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by male Hawaiian monk seals, and entanglement in marine debris led to six life-threatening conditions (Table 7.6). No deaths were recorded. One weaned pup and one adult female were disentangled by observers. In addition, an adult female was observed twice with a plastic loop around her neck, but was able to free herself both times. One female weaned pup was observed with a wound likely resulting from a shark attack. Observers intervened in single male aggression towards a weaned female pup.

ACKNOWLEDGMENTS

We acknowledge the support of the State of Hawaii, Department of Land and Natural Resources and Division of Forestry and Wildlife, especially Cynthia A. Vanderlip. We also thank the captains and crew of the NOAA ship *Oscar Elton Sette* and American Islander for logistical support and for transport to and from Kure Atoll.

TABLES
for Kure Atoll

Table 7.1.--Summary statistics for atoll censuses (n = 11) of Hawaiian monk seals at Kure Atoll from June 6 to July 14, 2003.

Size/Sex	Mean number of individuals	Standard deviation
Adults	31.8	4.4
Male	9.4	2.7
Female	14.7	3.1
Unknown	7.7	3.0
Subadults	4.2	1.6
Male	2.3	1.5
Female	0.5	0.7
Unknown	1.4	1.7
Juveniles	1.2	0.9
Male	0.5	0.5
Female	0.4	0.5
Unknown	0.3	0.5
Pups	9.2	2.1
Male	4.3	1.0
Female	4.3	1.6
Unknown	0.6	1.3
Non-pup total	37.3[a]	4.5
Grand total	46.5[a]	4.3

[a] Total includes some seals which were not placed in any size class.

Table 7.2.--Composition of the Hawaiian monk seal subpopulation at Kure Atoll during the spring and summer of 2003. Includes all known parturient females and pups born during the calendar year.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	26	33	59	0.8:1
Subadults	7	3	10	2.3:1
Juveniles	3	3	6	1.0:1
Pups	8	10	18	0.8:1
Non-pup total	36	39	75	0.9:1
Grand total	44	49	93	0.9:1

Table 7.3.--Summary of tagged known-age seals born at Kure Atoll and resighted at any location in 2003.

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1981	22	Male	3	0
		Female	5	0
1982	21	Male	1	0
		Female	3	1
1983	20	Male	4	2
		Female	0	NA
1984	19	Male	4	0
		Female	2	2
1985	18	Male	2	0
		Female	3	1
1986	17	Male	1	0
		Female	0	NA
1987	16	Male	1	0
		Female	3	3[a]
1988	15	Male	2	2
		Female	5	2
1989	14	Male	5	1
		Female	4	1
1990	13	Male	3	0
		Female	3	2
1991	12	Male	7	4
		Female	6	3[a]
1992	11	Male	5	3
		Female	8	4
1993	10	Male	9	5
		Female	4	2
1994	9	Male	3	0
		Female	0	NA

Cohort year	Age (years)	Sex	Number originally tagged	Number resighted in 2003
1995	8	Male	6	3
		Female	5	2
1996	7	Male	10	3
		Female	6	0
1997	6	Male	9	1
		Female	7	2
1998	5	Male	17	5
		Female	6	3
1999	4	Male	8	2
		Female	13	2
2000	3	Male	5	1
		Female	8	0
2001	2	Male	4	0
		Female	13	1
2002	1	Male	11	3
		Female	7	1

[a] Cohort survivors include seals removed from Kure Atoll for rehabilitation. These seals ($n = 2$) were released at Kure or Midway Atoll.

Table 7.4a.--Summary of Hawaiian monk seals born at Kure Atoll in 2003.

Event	Number of pups		
	Male	Female	Total
Born	8	10	18
Died prior to weaning	0	0	0
Weaned	8	10	18
Tagged	8	10	18

Table 7.4b.--Summary of nursing periods and measurements of weaned pups at Kure Atoll in 2003. Nursing periods were calculated where both birth and weaning date ranges were $\leq$ 4 d. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	32.0	110.6	126.2
Standard deviation	--	7.2	4.7
n	1	7	7

Table 7.5a.--Documented movement of Hawaiian monk seals to Kure Atoll from other locations in 2003, summarized by movements between two locations. No seals made more than one documented trip.

Original location	Number of trips, size, and sex class
Pearl and Hermes Reef	1 adult male 1 adult female
Midway Atoll	4 adult male 5 adult female

Table 7.5b.--Documented movement of Hawaiian monk seals from Kure Atoll to other locations in 2003, summarized by movements between two locations. Two seals made more than one documented trip.

Destination	Number of trips, size, and sex class
Lisianski	1 juvenile male
Pearl and Hermes Reef	2 adult male 1adult female
Midway Atoll	5 adult male 8 adult female

Table 7.6.--Factors affecting Hawaiian monk seal survival at Kure Atoll in 2003.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
Attack by Large Shark					
Weaned pup	Female	1	1	0	0
Mounting by Males					
Weaned pup	Female	1[a]	1	0	0
Entanglement					
Adult	Female	3[b]	0	0	0
Weaned pup	Male	1[c]	0	0	0

[a]An adult male was observed attempting to mount a newly weaned female pup for several minutes. Observers interrupted the event and noted that the pup sustained subdermal trauma and swelling.
[b]One adult had a polyurethane line around neck, released by observers; one adult was observed twice with a plastic loop around neck, freed self both times.
[c]Seal had a polyurethane line around neck, released by observers.

CHAPTER 8. THE HAWAIIAN MONK SEAL ON NIHOA ISLAND, 2003

Alexander S. Wegmann and Thea C. Johanos

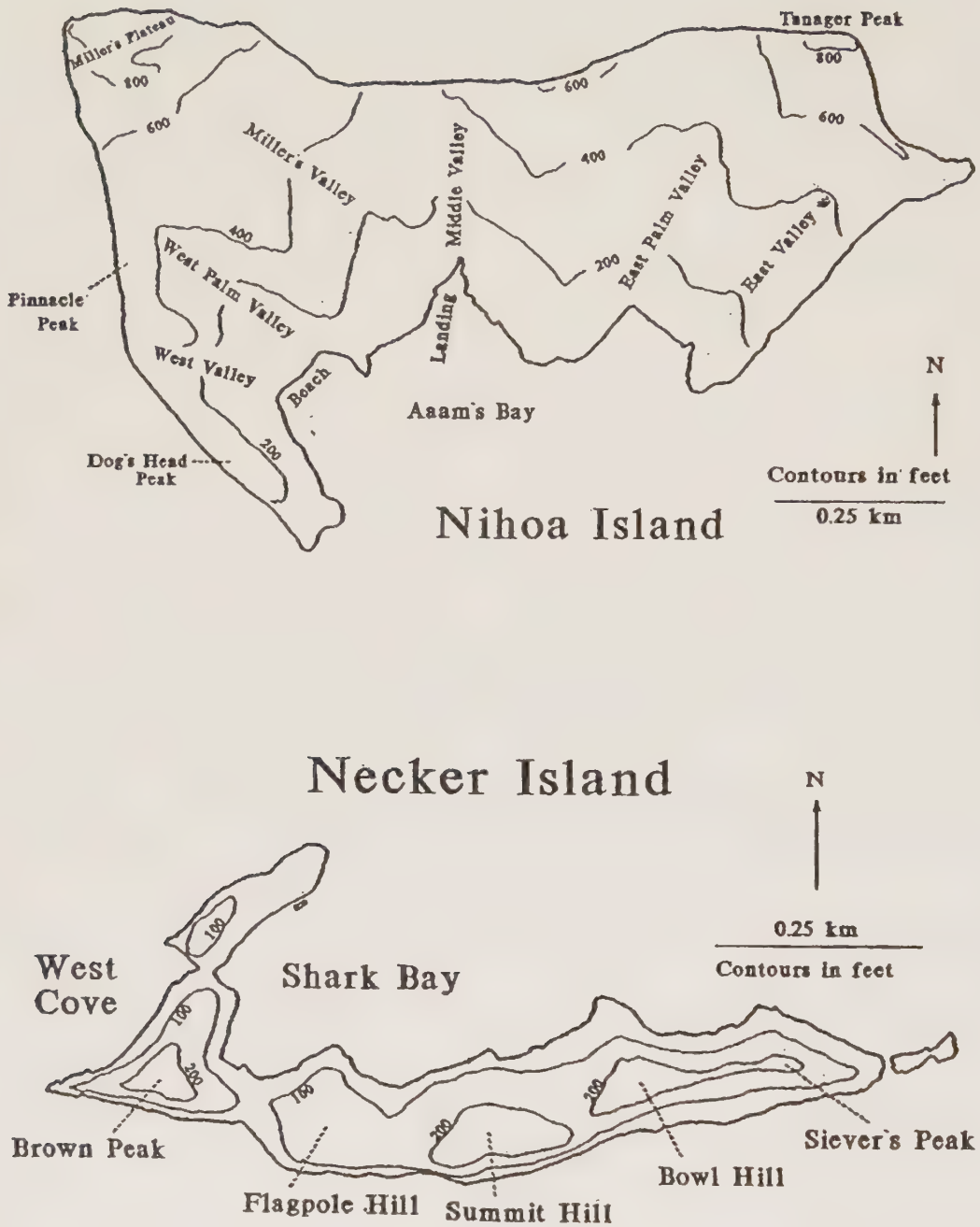

Fig. 8.1 Nihoa and Necker Islands in the Northwestern Hawaiian Islands.

Nihoa Island (lat. 23°04' N, long. 161°55' W) is located ca. 450 km northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1) and lies within the Hawaiian Islands National Wildlife Refuge. Although endangered Hawaiian monk seals use this island, their numbers are limited by lack of haulout area.

RESEARCH

In 2003, a survey was conducted at Nihoa Island on September 11. The perimeter of Nihoa Islands was divided into three sectors using natural landmarks (Fig. 8.1). In 2003, research objectives at Nihoa included assessment of pup production and obtaining a seal census count.

Censuses and Patrols

A beach count was conducted on Nihoa Island by two observers on September 11, beginning at approximately 1100 Hawaii Standard Time.

Individual Identification

No seals were identified on Nihoa Island in 2003.

Collection of Samples

No samples were collected at Nihoa Island in 2003.

RESULTS

Subpopulation Minimum Abundance and Composition

The census total for one count conducted on Nihoa Island was 27 seals (25 excluding pups). Because of limited effort, the composition of the spring-summer subpopulation was not determined.

Reproduction

At least two pups (of unknown sex) were born at Nihoa Island in 2003; one pup was still nursing and the weaning status of the other pup was unknown.

Interatoll Movement

Interatoll movement was not documented for seals observed at Nihoa Island.

Factors Affecting Survival

Factors affecting survival were not observed on Nihoa Island in 2003.

ACKNOWLEDGMENTS

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APPENDIXES

Appendix A.--Reports summarizing annual field research on the Hawaiian monk seal by the National Marine Fisheries Service and collaborating scientists.

All islands

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Appendix B.--Hawaiian monk seal census form and 2003 census form directions.

(See following pages.)

SEAL CENSUS FORM

ENTERED ☐

DATA TYPE _____ COMPUTER PAGE NO. ☐☐☐☐ PAGE _____ OF _____

ISLAND _____ OBSERVER ☐☐☐ TIME BEGIN ☐☐☐☐ END ☐☐☐☐

DATE _____ NUMBER _____ TEMP. ☐☐ WIND ☐☐☐ CLOUD ☐☐ Prec. ☐

Line No.	Continue	Time	Sector	Site	Sex	Beach Pos	Condition	ID			TAG				MOLT		Disturb	ASSOCIATION			Notes	Notes	EVENT	
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2003

CENSUS FORM DIRECTIONS

(Unabridged - Laysan and Lisianski Islands)

This form is used to record all Hawaiian monk seal and green turtle sightings. Turtle sightings are recorded only during census activities (not during patrols), unless noteworthy event occurs (turtle injured, tagged, tumored, mating, etc.). On the census form, all data that can be recorded for seals can also be recorded for turtles (although this data may not be required). **At French Frigate Shoals, do not record a data line for each turtle sighting; instead, write the total for each size/sex class at the bottom of the page.**

All original data should be coded in pencil. Never erase data once you have left the recording site. Instead, cross errors out with a single line so that the original information can still be read. Field editing is editing before running the data entry and checking program. All field editing by the data collector should be in blue, and field editing by others should be in red. As soon as you begin the entry and checking program, the computer will assign the computer page number and display it on the screen. At this point, be sure to fill it in on your census form. All editing after this point should be in orange. After completing the entry and checking program, check off and initial the ENTERED box on the census form.

A separate data sheet should be filled out for each date, observer, data type, and island within an atoll. If no seals are present, you should still fill out the information at the top of the census form and write "No seals" in the data area (only enter the header information and a blank line # 1). If the island itself is not present, indicate this by using 99 for the sector code, leaving the rest of the (first) line blank. To save paper, you should use a census form with multiple headers if you only have a few seals to record (i.e., at some islands within an atoll, or when recording incidental sightings before or after census or patrol). In essence, on a census form with multiple headers, each header and its associated lines represents a separate data sheet.

If two people conduct the census, they should have the same weather and the same begin and end time (i.e., both begin at the same time and place, and proceed in opposite directions until they meet on the other side of the island or islet) and combine pages into one set. Patrols may be conducted by more than one observer, but page sets are not combined, and header information may differ between page sets. Patrol observers should attempt to start at roughly the same time. The sum of all observers' patrol activity for a day should result in one complete island count.

Always record disturbance. You must be honest about this! Fill out a census form to document disturbance if you disturb a seal when you are not otherwise collecting data. On a census or atoll count, it is also assumed that condition and molt data will be taken.

Do not make up additional codes. If the need for an additional code arises, contact Honolulu.

PAGE HEADER

DATA TYPE

C =Census: A complete, timed count on an island begun around 1300. Census is conducted as quickly as possible (while gathering all information). Data collected on all seals and turtles.

A =

Atoll-wide census (must be completed within 2 consecutive days). Data collected on all seals and turtles.

B =

Behavior patrol: A complete, untimed count where size, sex, ID and disturbance are recorded. Associations are assumed to be coded for all seals. In 2003 collect at Laysan and Lisianski Islands; record spatial and pair associations, and paired male-male contests involving adult and S4 seals, otherwise code behavior X (data not taken). Record turtles only if noteworthy observation.

P =

Patrol: A complete, untimed count where size, sex, ID and disturbance are recorded. Behavior data is not taken. Record turtles only if noteworthy observation.

I =

Incidental observation. In this data type, null fields are interpreted as "data not recorded", so code data explicitly. If numbered, this indicates a full island incidental with year-specific goals. At Laysan and Lisianski Islands in 2003, these surveys will record mother-pup pairs, weaned pups, molters, survival factors (including severe harassments and mobbings) and other noteworthy observations.

T =

Tag status entry (to record that a given tag is now inactive/not on a seal). Record tag status (found or recovered) in notes columns.

COMPUTER PAGE NO.

Leave this blank during data collection. It will be assigned and displayed on the screen when you enter the data. At that time, be sure to fill in the computer page number on your census form, as this number is needed for data retrieval.

PAGE Page number within a census or patrol. For example, if the census (or patrol) requires three pages, then mark the first page as "page 1 of 3" and so on. If more than 1 person conducts the census, then combine page numbers; person A has pages 1 and 2, while person B has pages 3 and 4 of a four-page census day. The maximum number of pages in a set is 9. Header information (time begin/end, date, number, and weather) should be the same for all pages within a set.

ISLAND Name of island and atoll, e.g., East, FFS.

OBSERVER

Three initials. If no middle initial, use the first and last block.

TIME BEGIN and **END**

On a 24-h clock, e.g., 6 p.m. = 1800, for the group of pages. Midway uses Midway time, all other sites use Hawaii Standard time.

DATE The date that data are collected (in YYYYMMDD format).

NUMBER Censuses, Atoll counts, Behavior patrols, and Patrols must be numbered. Each data type will have its own 3 digit number series, starting with 001. For data types other than **A**, have a separate number series for each islet within an atoll.

Weather information (except temperature) should be a summary of the entire day up until the end of the census or patrol, not merely an instantaneous observation. Temperatures taken in the morning are not representative for the period of data collection.

TEMP. Temperature in degrees Celsius at beginning of census or patrol.

WIND Speed:0 = no wind, calm (<5 knots)
1 = light breeze (5-15 knots)
2 = strong wind (>15 knots)
Direction:NN,NE,EE,SE,SS,SW,WW,NW
Thus, 2 N N = strong wind from north

CLOUD Cloud cover: 00 = no clouds
01-09 = 10 to 90% cover
10 = 100% cover

PREC. Precipitation: 0 = no precipitation or trace
1 = mist/drizzle
2 = rain
3 = intermittent rain

LINES_

CONTINUE If the same seal sighting is recorded on several lines for any reason (e.g., additional tag or association, behavior at a later time, change of beach position, or photos), put the original line number you are continuing from here. Lines may be continued only within the same page. Fill in the original line as completely as possible. During entry, the data in all fields from TIME through MOLT must be copied from the original line if left blank on the continuation line. Do **not** copy other fields after MOLT (see entry directions for more information). Several lines can have the same continuation line number.

Make a new original line (i.e. do not use continuation lines) for a seal each time that you come abreast of it on census or patrol. This is important because beach position on the original line determines if a seal is counted on census (if the seal is ashore it will be counted). When recording paired male-male contests (at Laysan and Lisianski Islands in 2003), record contests as you see them ahead of you (within 30 m). When you come abreast of the seal, record the beach position and time and make this your original line. All previously recorded lines for this sighting will be reverse continuation lines.

TIME The time should be recorded for each seal sighting, on a 24-h clock

SECTOR Location on island (e.g., 1-20 on Laysan)
Special codes as follows:
00 = unknown sector (use also for areas without sectors,-i.e. middle of the lagoon)
77 = pen
88 = offshore spit/emergent reef
99 = island not present

SIZE Size is estimated using a classification scheme from Stone (1984), using the following terminology. Note that seals are "sized" by length, girth, appearance, and reproductive status, not by age (except pups):

Pup	Seals born within the calendar year. Newborn pups are black, and weight ca. 11 to 15 kg. Pups molt to a silver-gray pelage near weaning. Weaning weight is ca. 50 to 80 kg.
Juvenile	Short, slight seals from the length of a weaned pup (about 138 cm) to 20-30 cm longer; includes yearlings, and other young seals up to 3 years. Distinguished from pups by thinness and yellowish color.
Subadults	Seals perceptibly longer than juveniles up to breeding size; less robust than adults, generally with lighter pelage. Immature seals ca. 3 to 5 or 6 years old.
Adult	Reproductively active or breeding size seals at least as long as known breeders. Mature or probably mature seals. Adult females often have extensive back scars or wounds; adult males usually dark, including ventrum, and extensively scarred.

Code size as follows:

Pups of the year

- P0 = Fetus (aborted, clearly pre-term pup)
- P = Nursing pup
  - P1 = Nursing pup, wrinkles
  - P2 = Nursing pup, no wrinkles
  - P3 = Nursing pup, blimp, black
  - P4 = Nursing pup, molting
  - P5 = Nursing pup, molted
- PW = Prematurely weaned/undersized weaned pup (weaned $\leq$ 2 wks ago and < 90cm girth). Code as PW at time of weaning, and then can code as W for remainder of season.
- W = Weaned pup

Immatures

- I = Immature
  - J = Juvenile
    - J1 = Juvenile I
    - J2 = Juvenile II
  - S = Subadult
    - S3 = Subadult III
    - S4 = Subadult IV

Adults

- A = Adult

Unknowns

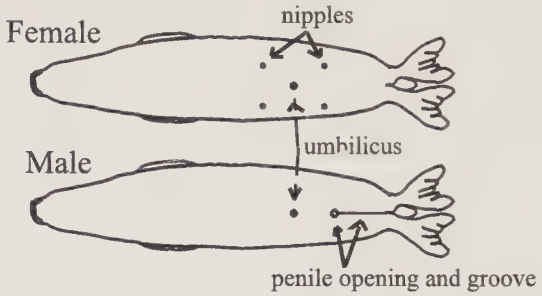
- U = Seal of unknown size

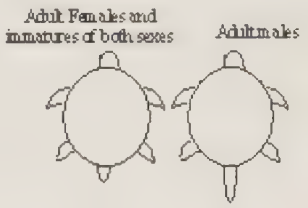
Turtles

- T = Turtle (lengths from anterior to posterior tip of carapace)
  - T1 = Turtle, juvenile (<65 cm straight carapace length)
  - T2 = Turtle, subadult (65 - 80 cm)
  - T3 = Turtle, adult (>80 cm)

Only code a seal's sex as known if the ventral is seen, even if you "know" the sex because of the tag, bleach, scars, or behavior. The only exception is that the mother in a mother/pup pair should be recorded as a female. The sex of a turtle can only be distinguished externally if it is adult-sized.

SEX M = Male
F = Female
U = Unknown





BEACH POS. Location of seal or turtle when observer comes abreast of animal (e.g., if seal is seen in the water from a distance and yet is on the beach when the observer come abreast, the seal is recorded as being on the beach). When recording paired male-male contests (at Laysan and Lisianski Islands in 2003), record contests as you see them ahead of you (within 30 m). When you come abreast of the seal, record the beach position and time and make this your original line. All previously recorded lines for this sighting will be reverse continuation lines.

0 = animal floating or swimming in water (not included in census tally but may be used for behavioral data or other analysis).
1 = on the beach (or regularly surveyed areas on the fringing reef for **Midway Reef Surveys**)
9 = on an offshore rock/reef with no connections to the island. Separated from shore by a deep channel or substantial distance, and not regularly surveyed (not included in census tally). For **Midway Reef Surveys**, use beach position **9** for the back side of the reef and other areas that are not regularly surveyed.
X = data not taken

CONDITION Condition is recorded for all seals (except nursing pups) on census or atoll count. **Always record** the condition of the mom on her first sighting postpartum, and of the mom and pup on their first sighting post-weaning, regardless of data type. Always note condition when recording a survival factor. Unusual conditions should be further described in **Notes**.

Condition codes:
M = medium
P = probably pregnant
F = fat
T = thin, includes emaciated (ribs visible, neck obvious, concave dorsal musculature)
X = data not taken
Codes F and T indicate extreme conditions, seals that are medium-fat, or medium-thin should be coded as medium. **Always code condition explicitly**.

A seal is either identified or not during a sighting. If both the ID No. and Tag No. fields are empty, the seal is unidentified. If either the ID No./Tag No. field is filled, the seal may be identified depending on how the ? columns are filled. Questionable codes blank, 0, or 4 indicate the seal is identified with certainty, whereas codes 1 or 5 indicate uncertainty. If a seal's identity is confirmed by any method, coding for the entire sighting (on the original line and all continuation lines) must ultimately show certainty. For example, if the ID columns indicate the seal is identified with certainty but the Tag columns indicate uncertainty, look up the correct tag number during data editing, enter it, and change the Tag? code from uncertain (1 or 5) to certain (4)).

ID DATA These fields can be used to record either a temporary or permanent ID number. Although the paper form only has one ID field, the database actually has two ID fields. Thus, you can record both a temporary and a permanent ID number on a seal's original line (to do this on the form, split the ID field horizontally and write both numbers on a single line, or expand the original line by sacrificing the subsequent line). Use continuation lines to record two or more temporary numbers. If the seal is identified, it will not be counted twice on census. To link two sightings of an unidentified seal during a survey (i.e. for a cruiser moving ahead of you), assign it a temporary number in a series reserved for unidentified seals, and code a 6 in the temp ? field.

T/P Indicate whether the number in the subsequent field is a temporary or permanent ID number.
T = temporary ID number (or bleach number)
P = permanent ID number

TEMPORARY ID NO. Record the temporary ID number (or bleach number) of seal if known; right justified. This field may be used for any temporary number. Use separate number series for bleach and various types of temporary numbers. If a number is incompletely read, use dashes as place-holders within the number to indicate missing digits (e.g., incompletely read bleach 152 may be coded -52, 1-2, or 15-).

? column:

- 0 = seal is definitely unmarked; can coexist with a non-bleach temporary number, or with a bleach number if bleach hasn't taken yet or the number has molted off
- 1 = bleach is present but the recorded bleach number is questionable, **and the seal is not identifiable** from other information
- 4 = partially read bleach number completed from other data
- 5 = incompletely read bleach number, there isn't enough information to identify the seal but the partial data are certain, **the seal is not identifiable** from other information
- 6 = temporary number valid for this survey only (for unident. cruisers moving ahead of you on census, etc.). Use a special number series so these numbers are not confused with real temporary ID numbers. Numbers may be reused on the next survey for different seals.
- blank = number is certain and complete if present

PERMANENT ID NO. Record the 4 digit permanent ID number of seal if known (put both the island-specific prefix and next digit in the first box provided).

? column:

- 1 = ID number is questionable, **and the seal is not identifiable** from other information
- blank= ID number is certain and complete if present. A Permanent ID is not visible, and is always completed from other data. For certain ID numbers, **always use ID? = blank, not ID? =4.**

TAG NO. The complete tag number if known; right justified. If a number is incompletely read, use dashes as place-holders within the number to indicate missing digits. Put the alpha prefix of the temple tag (combined with tag ? column code = 5) if you can determine the hole drilling pattern, but can't decipher the number (e.g. A--RT5 for a right tan tag with a 1983 drill pattern). Explain how you came up with the prefix, and draw the hole drill pattern in Notes.

Record all tag sightings explicitly (i.e., both left and right tag numbers) at least once during your stay. During the first weeks of the field camp, note tag condition each time that a tag is sighted. Once the majority of tags have been resighted, observers can carry a list of tags/individuals that haven't been seen, and only note tag condition if these tags/individuals are resighted. Also carry a list of broken or lost tags, and current tag conditions, so that you will be aware, and can record, if a specific tag breaks or is lost, or a tag condition changes during the field season. When a pup is tagged, record the animal handling event on the census data sheet, and record detailed information (such as all tag numbers, all temporary numbers, and the permanent number) on a Tagging/Handling card. If a seal is identified via a tag, it is not necessary to determine and enter its ID number on the census form. The ID number can be determined by computer later.

L/R: Tag position

L = tag on left flipper
R = tag on right flipper
B = tags on both flippers (enter one tag number). This code can be used if the seal has only 2 Temple tags (one on each flipper).

COL: Color code -see the Tag Sample Kit if unsure of the colors

Temple tags	Other tag types
Y = yellow (FFS)	M = metal, Monel
T = tan/brown (Laysan)	C = clear, PIT tag
G = green (Lisianski)	
B = blue (Pearl & Hermes)	
K = silver/gray (Kure)	
R = red (Midway, Necker, Nihoa, Main Islands)	

? column:

0 = seal is definitely not tagged on **either** flipper. To indicate that a seal has lost a tag, code a known missing tag using tag? code 8. If the tag number is unknowable, write the information in Notes.
1 = seal is tagged but the recorded tag data are questionable, and **the seal is not identifiable** from other information
4 = partially read tag completed from other data
5 = incompletely read tag, there isn't enough information to identify the seal but the partial data are certain, **the seal is not identifiable** from other information
8 = a specific tag is lost/unreadable. Fill out tag position (L/R) and the tag condition event with codes L or U. Complete the tag number and color from other data before entry.
blank = tag information is certain if present. Partial data (either complete Tag #, position, or color not filled) are OK and will be completed by computer if the seal is identified by ID, Temporary #, or Tag #, and there is only one possible tag for that flipper. The computer will only fill blank fields, so an incomplete Tag # must be completed by hand (use a "4" in the tag ? column).

MOLT Percentage of old pelage lost, optional for pups. However, for weaned pups, record the % molt at time of tagging. Record molt as 100% for at least 1 month post-molt. Code the full percentage (1 to 100%) in the single box provided.

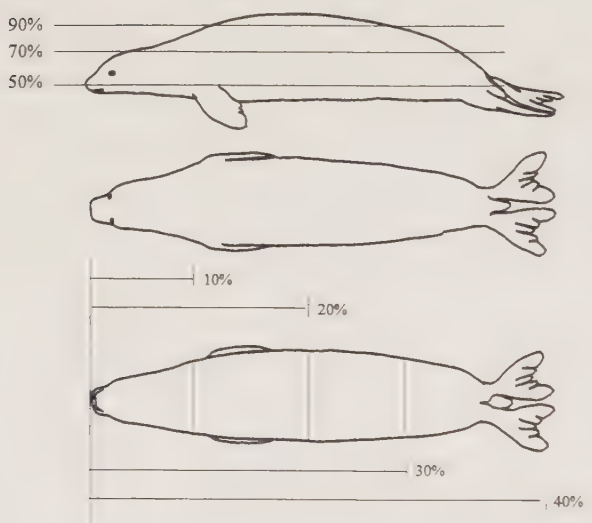
blank = no molting evident
1 to 99 = 1 to 99% molted. The first signs of molt usually occur around the eyes, nose, flippers, and scars. **The first record of >10% of the old pelage molted off is considered the first day of true molt.**
100 = 100% molted, freshly molted, **required for the first month after molt**. Put all 3 digits of the 100 in the single box provided.

? column:

0 = seal is definitely not molting
1 = seal is molting, but % molt estimate is questionable. May or may not include an estimate in the molt column

"End of season" editing codes that override erroneous molt estimates:

2 = seal in molt
3 = seal pre-molt
4 = seal post-molt



DISTURB The degree to which the seal may have been disturbed by observer. Record disturbance every time a seal is disturbed, regardless of your activity. The only exception is that you do not need to record a disturbance for a seal that you are handling (i.e., tagging, disentangling).

0 = no disturbance, or seal merely raised its head or looked at observer - If column **blank**, 0 is assumed
1 = seal vocalized, gestured, or moved $\leq$2 body lengths
2 = seal alerted to observer and moved >2 body lengths
3 = seal alerted to observer and fled into water

ASSOCIATION DATA

Behavior data is collected at Laysan and Lisianski Islands because adult male aggression has been more commonly observed at these locations, resulting in injury and death of adult female and immature seals. At Laysan, these data were used to identify 37 males for removal in a successful management action that reduced the adult sex ratio and increased female survival. Data are now used to monitor the long term effects of sex ratio adjustment at Laysan, and assess management options at Lisianski Island.

Record spatial and pair associations involving adult and S4 seals at Laysan and Lisianski Islands in 2003. Don't record associations that only involve S3 or smaller sized seals or associations that involve turtles. If you wish to indicate that a seal was alone, use the O (this code is alpha, not zero!) behavior code. If you do not record association data on a census or behavior patrol at Laysan or Lisianski Island for any reason, indicate this with an X for the behavior code. **Always explicitly record whether the seal is unassociated or association data is not recorded.** Use continuation lines to record more than one association.

An association should either be all blank or have the O, Z, or X behavior only (with no line number or distance), or have a line number, a distance, and some behavior code (other than O or X) all present.

All associations should be recorded in pairs, i.e., between animals on two different lines. You should fill in the line numbers, distances, and behavior codes for both animals involved in the each association. The association line number should refer directly to the line where the corresponding behavior is coded (i.e. if the corresponding code is on a continuation line, refer to that particular line, not to the original line or a different continuation line). If two seals are associated, the time recorded on their lines doesn't need to match, but should be within 30 minutes of each other.

Active associations will not be recorded in 2003. However, if a **paired male-male** contest occurs write a

brief summary in **Notes** and code the contest outcome (see the attached **CONTEST RULES**).

Spatial associations

1) noted as observer comes abreast of the subject
2) individual seals
   - mother-pup pair (N): any distance
   - Adult or S4 seals (L): distances ≤10 m away, record two nearest neighbors in a straight line of sight. Seals can be on opposite sides of a log, etc.

LINE NO. Identity of the other seal in the association. Put its line number here (note line number refers to within same census page only).

DIST. Closest distance during behavior - both associated lines must have the same minimum distance.

0 = body contact
1 = <2 m
2 = 2-5 m
3 = >5 m (>5 m but ≤10 m in the case of L behavior code)

BEHAVIOR Up to four behaviors may be recorded for each association, but L, N, X, and O should not appear together with other behaviors. If there is a **paired male-male** contest write a brief summary in **Notes**. **Focus on the major points**, such as the seals involved, pairings before and after the interaction, the contest winner/loser, and the most intense behaviors (joust, bite, mount, chase, displace).

1) individual seal

a) spatial association

N =mother-pup pair (any distance), does not imply actual nursing behavior. This is the only association recorded between mother-pup pairs, and the N code must be on the original line for each pair member. If there is an unusual event (i.e., birth, weaning, or pup switch) write a brief summary in Notes and use the appropriate Notes Code.

L = association by location only (distance ≤10 m apart, for all except mother-pup pairs)

Z = cruising **(OPTIONAL CODE)**. A/S4 only behavior (actual sex may be unknown). Does not require a line number reference to another seal, but may have one.

b) additional codes (Laysan and Lisianski 2003)

*L1 = pair assoc. A/S4 male actively defends an adult female or immature of either sex (actual sex may be unknown), or establishes a pair relationship with a female or immature after displacing another male. Code the L1 relationship both before and after the contest if a displacement occurs.

*Q = loser (quitter)

*W = winner

*Y = tie

Note: codes Q, W, and Y are used for A/S4 male-male contests only, although the actual sexes may be unknown (in which case record as though they were known to be males); see the attached **CONTEST RULES**.

* requires a corresponding code on the line of the associated seal

Code	Corresponding code
N	N
L	L
L1	L1
Q	W
W	Q
Y	Y

2) nothing nearby

O = no behavior or association

3) no data

X = no association data recorded on Census or Atoll Count

NOTES--There is room to code 2 different notes. Always use the first column first. Code an H if you have handwritten notes on the observation. Put handwritten notes on the bottom of the census form, labeled by line number. If more than two note codes apply, use continuation lines.

A = artwork (scars drawn) - attach drawing, labeled with date, island, observer, data type, page number, and line number
B = birth, 1st sighting postpartum (mom and pup)
G = seal is green with algae
H = handwritten notes
M = marked, indicate each time a seal is bleached (includes attempts to bleach)
W = weaning, 1st sighting post-weaning (pup or mom, whichever sighting confirms weaning or end of nursing (i.e., mom alone after pup disappearance).
X = pup exchange, 1st sighting after exchange (mom and pup)
Y = disturbance is to "bystander" seal during non-survey activity such as tagging, bleaching, instrumenting, disentangling, etc. This includes all animal handlings/"hands on" research, even if the attempt was unsuccessful (i.e., removing dead pups, cutting umbilical cords, or reuniting pups with their mothers).

FOR DATA TYPE "T" (TO RECORD THAT A GIVEN TAG IS NOW INACTIVE/NOT ON A SEAL):
F = tag found
R = tag recovered from seal in hand

EVENT These columns are used to record a variety of data. The codes used will depend upon the type of event that you wish to record. Left justify your coding:

TYPE	CODES COLUMN	CONTENT
F = survival factor		ONLY RECORD RESIGHT OF A SURVIVAL FACTOR AS AN EVENT IF THERE ARE IMPORTANT CHANGES TO DOCUMENT, SUCH AS A NEW WOUND, HEALING, DEATH, ETC., TRANSCRIBE NOTES TO SURVIVAL FACTOR FORM. For turtles, use a different survival factor number series (i.e., begin at 500), fill out a survival factor form (or use an alternate format if specified by mtrp), but do not enter the data into the seal survival factor database.
	1-3	Survival Factor number
	4	Factor Type. If seal dead, always record factor type "D" on ORIGINAL LINE. For mobbings/ harassments, always code a census entry with factor type "M" for the victim at the beginning and end of the incident. Otherwise, you only need to record the most appropriate factor type if more than one applies. D = death W = wound (includes abscess/raised area) E = entanglement V = very thin (emaciated)

I = illness/abnormal (includes eye disease)
M = mobbing/harassment/post-mobbing aggregation
O = other

5 Participant type (for mobbings/ harassments/post-mobbing aggreg. only)
V = victim/subject
M = male aggressor

H = handling of wild seal

HANDLINGS DO NOT NECESSARILY INVOLVE RESTRAINT OF THE SEAL. FILL OUT BOTH A SEAL SIGHTING (WITH HANDLING EVENT) AND A TAGGING/HANDLING CARD. For direct translocations, fill out two seal sightings (one each at the time of capture and at the time of release) and fill out a single tag/handling card with restraint time from capture until release into the wild. In cases where the translocated seal is held in a pen before release into the wild, fill out four seal sightings (one each at the time of initial capture, "release" into pen, "capture" in pen, and release into wild) and fill out two tag/handling cards, one at the time of initial capture (with restraint time until "release" into the pen) and a second card at the time of "capture" in the pen (with restraint time until release into the wild).

1 Handling type
T = tagging (w/ restraint)
M = measuring (includes weighing)
A = all (both tagging and measuring)
R = remote tagging
D = disentangle (even if not restrained)
I = instrument application
B = bleeding
C = take from the wild into captivity (or capture for translocation)
F = free from captivity (or free after translocation) into the wild
O = other (includes instrument removal and "captures/releases" of seals within a pen)

TYPE	CODES COLUMN	CONTENT

P = photo

SEAL OR TURTLE PHOTOS ARE THE ONLY PHOTOS CODED ON THE CENSUS FORM. OTHER PHOTOS SHOULD BE RECORDED IN NOTES, AND TRANSFERRED TO THE PHOTO COMMENT FORM.

1 Type of photo
S = slide
P = print
D = digital

2-5 Digital: Consecutive File Number, **or**

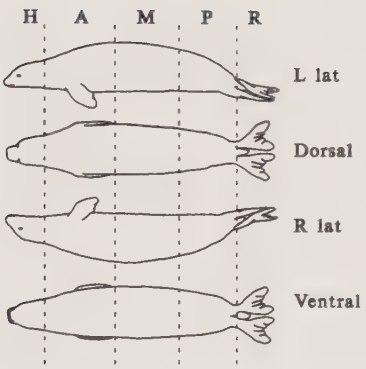
Film: columns 2-3 Roll number (pad with zeros)
columns 4-5 Frame number (pad with zeros)

6 Side

- L = left lateral or flipper
- R = right lateral or flipper
- D = dorsal side
- V = ventral side
- B = both (used for rear flippers only)
- X = other, describe in hand-written NOTES

7 Part

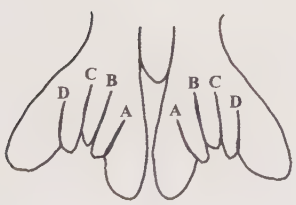
- H = head
- A = anterior body (neck and shoulders)
- M = midbody (behind fore-flippers and before posterior)
- P = posterior body (behind midbody and before rear flippers)
- F = foreflipper; write whether dorsal/ventral in comments
- R = rearflipper; write whether dorsal/ventral in comments
- O = overall view of a particular side
- X = other, describe in comments



8 Purpose

- I = identification
- F = survival factor (link with survival factor EVENT using continuation lines)
- X = other, describe in comments

TYPE	CODES	CONTENT
	COLUMN	
T = tag condition		RECORD TAG CONDITION FOR BOTH SIDES OF EACH TAG AT LEAST ONCE DURING THE SEASON. If tag condition is recorded for an incompletely read tag, complete the tag number (with appropriate tag? Code) prior to computer entry.



1 Web

- A-D = from inner (medial) to outer web.
- E = ankle
- P = posterior
- U = unknown

2 Side of tag, the dorsal tag side is on the dorsal flipper surface unless the tag is reversed. For Temple Tags, the dorsal side is the bigger side; for Metal (Monel) tags, the dorsal side is the "male" side. For PIT tags, code the side as B (both).

D = dorsal
V = ventral
B = both
U = unknown

3 Condition, code U (unreadable) if cannot use tag to ID seal (i.e. if broken so number gone). Also code U for a PIT tag if you completely scan for it with a reliable reader but get no reading. If reader is unreliable, put attempt in Notes and only code PIT tag as unreadable after 3 separate attempts. Combine the L or U codes with the tag questionable code of 8. You can combine the tag questionable code of 8 with other condition codes to describe why the tag is unreadable (i.e., worn or broken). Unreadable tags can still be used as partial information to help determine a seal's identity. Code more than one condition using continuation lines.

B = broken
F = faded color
G = good
L = tag lost
N = no/partial resin
O = other
P = pulling out
U = unreadable
V = tag side reversed
W = no. worn /abraded

CONTEST RULES

1. **Male-male contest definition** (must conform to at least one condition below):
   a. Distance between adult males = 0
   b. Either adult male vocalizes, chases, displaces or jousts with the other male

2. **The contest outcome depends upon pair type** (what size/sex seal the adult male is paired with)
   a. For contest rules, size S4 seals are considered to be adults (both sexes), seals size S3 or smaller are considered to be immature
   b. Definition of (**L1**) pair type:
      i. Pair type **#1**: adult male paired with (actively defending) an adult female
      ii. Pair type **#2**: adult male paired with (actively defending) an immature seal of either sex

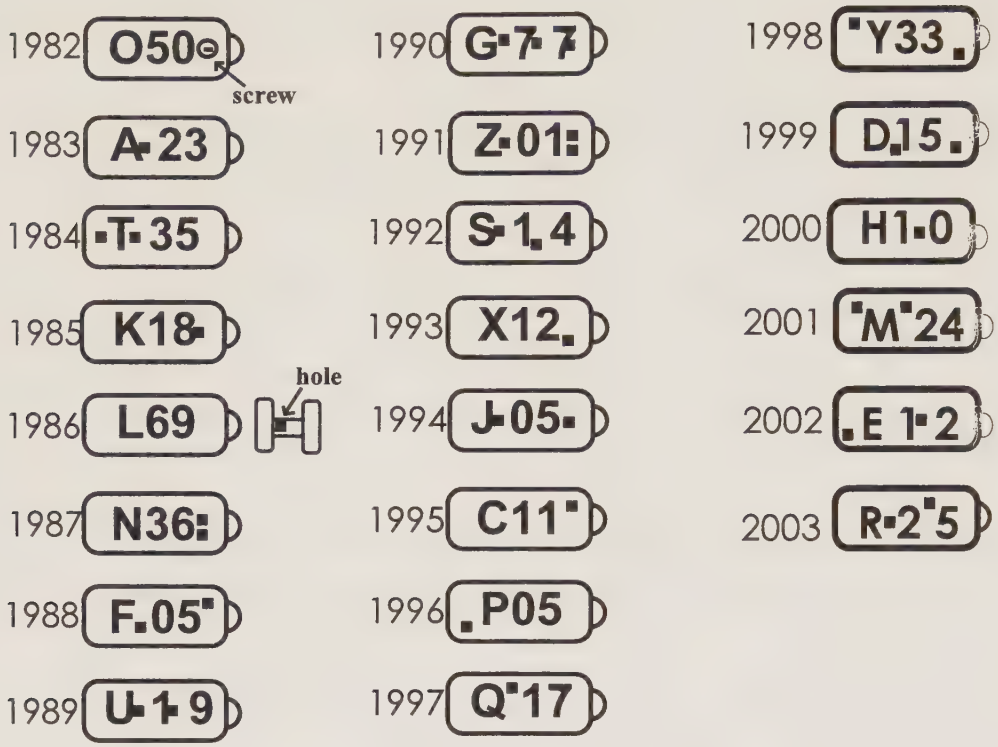
3. **Contest outcomes** (definition of winner or loser adult male):

Case		Winner (**W**)	Loser (**Q**)	Tie (**Y**)
Paired Male *vs.* Single Male:	i)	The paired male wins if he is not displaced	Unsuccessful single male	No Ties
	ii)	The single male wins if he displaces the original paired male	Displaced originally paired male	No Ties
Male Paired with Adult Female *vs.* Male Paired with Immature Seal: (**#1** *vs.* **#2**)	i)	The male paired with the adult female wins if he is not displaced	Unsuccessful male paired with immature	No Ties
	ii)	The male paired with the immature seal if he displaces the male originally paired with the adult female	Displaced originally paired male	No Ties
Paired Male *vs.* Paired Male of equal pair type: (**#1** *vs.* **#1** or **#2** *vs.* **#2**)		Displaces the other seal	Is displaced	Tie if neither seal is displaced

4. **Generalizations:**
   a. **Unequal pair types**
      i. There are no ties
      ii. The male with the **higher pair type (1>2) always wins unless he is displaced**
      iii. A seal can win without being aware of the contest. For example, if the "winner" is not aware that the other seal flees, but that seal fled in response to a vocalization, then code the fleeing seal as the loser (Q) and the other seal as the winner (W))

   b. **Equal pair types**
      i. **Males tie unless there is a clear winner/loser**
      ii. To win, a male must displace the other male

HAWAIIAN MONK SEAL TEMPLE TAGS: NUMBERING SCHEME AND HOLE DRILLING PATTERN FOR TAGS APPLIED TO WEANED PUPS



Be sure to code the original tag color, not the color that a tag has faded to. See the Tag Sample Kit.

Original tag color:	Faded tag may appear:
Temple Tags:	
Yellow	White, Lt. Yellow
Light Tan (A,T,K,L series @ Laysan)	Gray, Lt. Yellow, White
Dark Tan/Brown (later series @ Laysan)	Red
Dark Forest Green	Dark Blue, Navy
Kelly Green (C, P, and Y cohorts)	--
Blue (light)	--
Red	Orange
Gray (A,T,K,L,N,F,U,G series @ Kure)	Light Tan
Silver Gray (600-900,0,Z and later @ Kure)	Metal

Availability of NOAA Technical Memorandum NMFS

Copies of this and other documents in the NOAA Technical Memorandum NMFS series issued by the Pacific Islands Fisheries Science Center are available online at the PIFSC Web site http://www.pifsc.noaa.gov in PDF format. In addition, this series and a wide range of other NOAA documents are available in various formats from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, U.S.A. [Tel: (703)-605-6000]; URL: http://www.ntis.gov. A fee may be charged.

Recent issues of NOAA Technical Memorandum NMFS-PIFSC are listed below:

NOAA-TM-NMFS-PIFSC-3 Modeling a very rare event to estimate sea turtle bycatch: lessons learned.
M. L. MCCRACKEN
(November 2004)

4 Evaluation of time-area closures to reduce incidental sea turtle take in the Hawaii-based longline fishery: generalized additive model (GAM) development and restrospective examination.
D. R. KOBAYASHI and J. J. POLOVINA
(March 2005)

5 The Hawaiian monk seal in the Northwestern Hawaiian Islands, 2002.
T. C. JOHANOS and J. D. BAKER (comps. and eds.)
(July 2005)

6 A sociocultural assessment of Filipino crew members working in the Hawaii-based longline fleet.
S. D. ALLEN and A. GOUGH
(October 2006)

7 Sea turtle and pelagic fish sensory biology: developing techniques to reduce sea turtle bycatch in longline fisheries.
Y. SWIMMER and R. BRILL
(December 2006)

8 Hawaii longline fishermen's experiences with the observer program.
S. STEWART and A. GOUGH
(February 2007)